Materials & Methods

APRIL 1953

Metal Powder Show Preview

Materials Engineering at Northrop

Machinability of Metal Powder Parts

High Density Alloys for Heavy Weight Applications

Fluorocarbon Plastics—What They Can Do

When to Use Large Spun Metal Shapes

Flame-Hardened Parts for High Production

Properties of Electrodeposited Nickel

New Glass Fiber Mat

Where Electrically Conductive Rubbers Are Useful

MAGNETIC MATERIALS

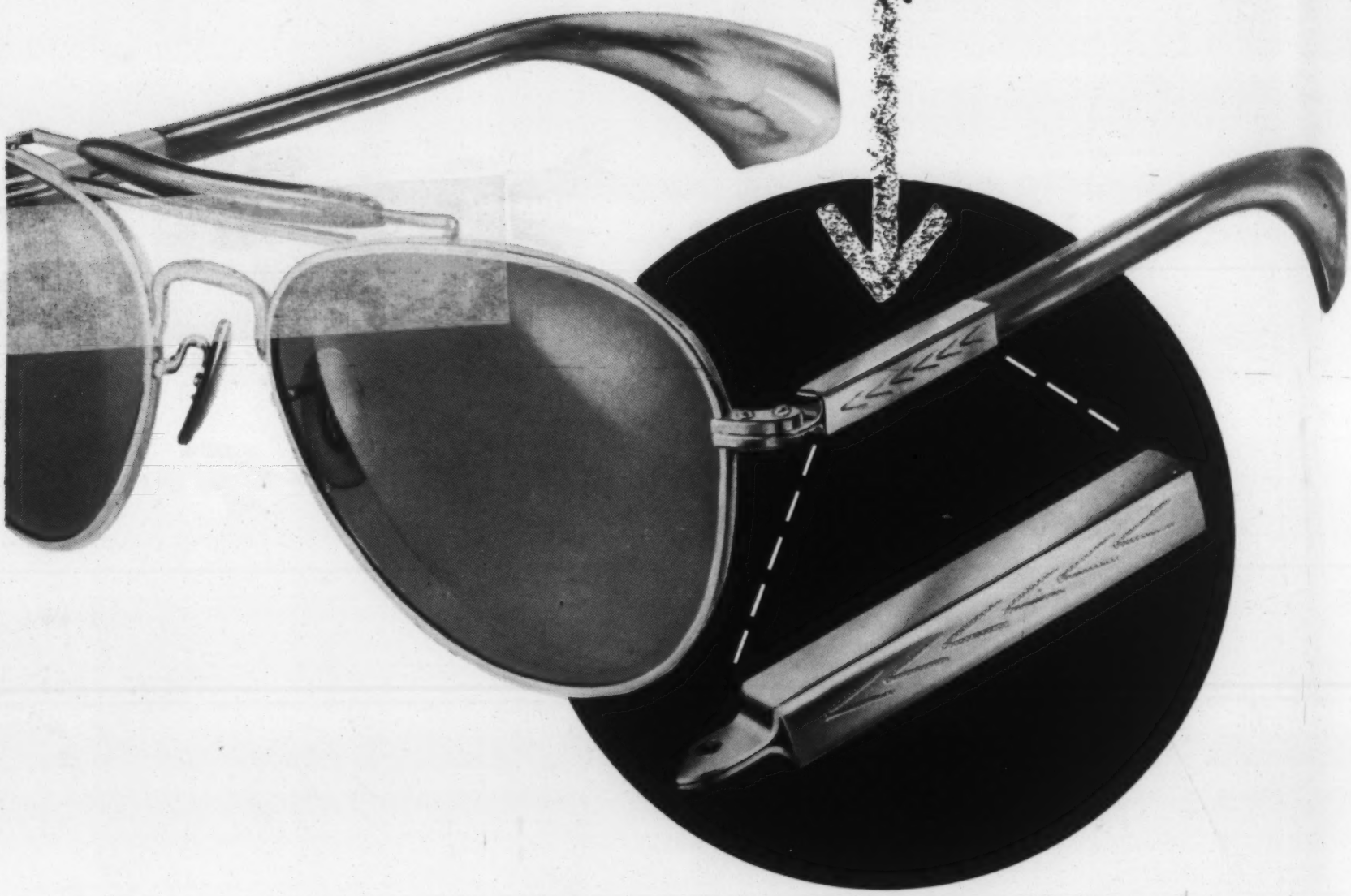
—Materials & Methods Manual No. 93

THE MAGAZINE OF

MATERIALS ENGINEERING

DEVOTED TO THE MATERIALS PROBLEMS OF PRODUCT DESIGN AND MANUFACTURE

Formbrite's *superfine finish*
eliminated buffing
on these parts



For the temple bow illustrated, Sunware Products Inc., New Britain, Connecticut, makers of Rayex Sun Glasses, formerly used ordinary drawing brass and finished this part by hand buffing—one at a time.

This was a costly procedure, so a switch was made to Formbrite* . . . then a happy thought occurred:

With Formbrite's superfine grain structure and added surface hardness, why not *tumble* these bows—by the thousands.

It was as simple as that. Formbrite's clean, smooth surface produced a jewelry finish—ready for gold-plating and lacquering. Since these bows are produced by the millions, the savings effected were substantial.

Formbrite, just in case you haven't heard, is a superior drawing brass. Comparative tests prove conclusively that the superfine grain structure of this specially processed forming brass means stamped and formed products that are stronger, harder, "springier" and more scratch-resistant. Yet the metal is so ductile that it can be readily formed, drawn and embossed.

Time studies made of finishing operations have shown that a bright, lustrous finish ordinarily can be obtained by a simple "color buffing" operation—or by tumbling, if the product lends itself to this method.

And yet, Formbrite costs no more. Convince yourself that Formbrite is the metal for your product. Write for Publication B-39. Address The American Brass Company, General Offices, Waterbury 20, Conn. In Canada: Anaconda American Brass Limited, New Toronto, Ontario.

5386

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Materials & Methods®

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Another new development using

B. F. Goodrich Chemical *raw materials*

Stove manufactured by Rogers Tool & Die Co. Inc., Akron, Ohio. Rubber parts molded by Stalwart Rubber Co., Bedford, Ohio. B. F. Goodrich Chemical Co. supplies the Hycar rubber only.

HYCAR lends a hand in front-line cooking!

THIS ingenious Army portable stove can cook a meal in a jiffy with safety! It can also be carried around in any position without leaking its gasoline fuel.

Hycar helps it do its job—in two important ways. One is in the built-in air pump which forces the gasoline fuel into the burning jet. At the pump-bottom is a check valve which is always immersed in gasoline. The valve seat must resist the fuel's deteriorating effects—and it *does,* because it is made of Hycar nitrile-type rubber. Hycar is extremely resistant to petroleum products—assures retention of original shape because of its good compression set and resistance to cold flow.

Around the fuel tank filler cap is a Hycar seal, which prevents leakage of the gasoline fuel, no matter how the midget stove is carried. Protection for the serviceman *and* the stove. The Hycar valve seat and gasket meet military specifications MIL-S-107368.

Hycar rubber compounds are used in many applications. For Hycar can be made resistant to heat and cold, water, weather and wear, gas, oil and many chemicals. Perhaps Hycar can help you solve a tough problem, develop or improve more saleable products. For technical bulletins, please write Dept HR-2, B. F. Goodrich Chemical Company, Rose Building, Cleveland 15, Ohio. Cable address: Goodchemco. In Canada: Kitchener, Ontario.

B. F. Goodrich Chemical Company
A Division of The B. F. Goodrich Company

Hycar
Reg. U.S. Pat. Off.
American Rubber

GEON polyvinyl materials • HYCAR American rubber • GOOD-RITE chemicals and plasticizers • HARMON organic colors

The Materials Outlook

Unusually good ductility of a new iron powder makes it applicable for finished machine parts such as gears, cams and brackets. With properties comparable to those of mild carbon steel, sintered parts of the new powder are said to withstand pressures up to 70,000 psi without cracking.

A fireproof decorative surfacing material has been achieved with the sandwiching of 1/16-in. aluminum sheet between layers of melamine plastic.

Seemingly contradictory testimony on creep strength of titanium appears to be resolved by new data. It shows titanium having relatively low creep strength at room temperature, normal creep properties at temperatures above 600 F, and practically no creep at all in the range 400 to 600 F.

A complex nickel-chromium-molybdenum-base alloy has been developed to obtain corrosion resistance representing a compromise between the high resistance of austenitic stainless steels to oxidizing conditions and the high resistance of nickel-molybdenum alloys to reducing conditions.

Fluorocarbons, among the highest priced of all plastics, are expanding. By the middle of the year a third large resin manufacturer will be marketing one of these materials, specifically: polychlorotrifluoroethylene.

Campaign to conserve nickel and cobalt will be launched soon by the National Production Authority. Magnet manufacturers, trying to get increased allocations of both metals, are more likely to get a cutback, at least in cobalt, plus magnet design restrictions. . . . No immediate easing of the tight nickel plate situation is foreseen. However, this entire field may see some radical changes with the recent advent of a commercially feasible chemical plating process for nickel. The new chemical process is said to make possible high-quality nickel plates on solid material of any shape or size. The predictable uniformity and nonporosity of the deposit mean that equivalent corrosion protection can be obtained with a 50 to 60% saving in nickel, compared to electroplating. (For more details, see forthcoming article in May issue).

Availability of polyethylene for civilian products might get worse before it gets better due to possible stepped-up military requirements. But with the slight production increase this month, larger increases later this year and substantial boosts in the next few years, long-term supply outlook for this material is good.

Two new refractories have been developed. One, made from rice hulls,

(Continued on page 4)

The Materials Outlook *(continued)*

has a density less than that of water, is said to equal the best refractory insulators, and can be processed to compete with other materials. The other, a mixture of aluminum and alumina, has high thermal shock resistance and sufficient modulus of rupture to make it useful in jet engines. . . . A chemically-combined expanded concrete developed in Sweden and widely used in Europe will be in production in this country by the end of the year. Although primarily a building material, its light weight and high insulation efficiency make it attractive for many refractory applications.

Silicone-treated porous nickel sheet which will pass air freely but bar water having pressure less than 3 psi is being produced. One use is to protect delicate aircraft electronic instruments from water without building up air pressure differentials during altitude changes.

High density alloy metal powder parts of unusual and non-symmetrical shapes, previously difficult or impossible to produce, are now being made by a technique called "contour pressing." Said to eliminate cracking and distortion by insuring uniform density, the novel method is expected to expand still further the design possibilities of powder metal parts.

An important future for reinforced phenolic low pressure laminates where heat resistance is required, as in airframes of sonic aircraft, is indicated by development work now underway in this country and Great Britain.

Continued fluctuations in steel, copper and zinc prices can be expected. Look for rising prices on some steel products. . . . Best guess on a stabilized copper price is close to 30¢ a lb. . . . Zinc and lead are likely to remain low for some time until British metal glut and domestic inventories are consumed. If price situation closes enough mines, however, tight supply and higher prices might develop later.

A stain-resistant baking enamel, claimed to be 50% harder but much more flexible than conventional enamels, is expected to compete with galvanizing and porcelain as a finish on some familiar consumer items.

An acrylic plastic having greater resistance to crazing and heat than presently used acrylics is now available. It has resisted crazing under stresses up to 4000 psi in toluene solvent.

A new composite gasket material combines the heat resistance of asbestos and the compressibility of Neoprene. In both of these respects and in dimensional stability, it surpasses glue-glycerine treated paper, also used as a "compromise" gasket material.

A new versatile, resistant resin adhesive is available. Claimed to bond almost any nonporous materials, the resin when cured resists boiling water, acids, alkalies and most organic solvents.

With INCONEL heat-treating fixtures...

you take the dents out of accidents!

After a furnace pile-up in one plant recently, the fixtures looked pretty hopeless.

Some were bent and broken, like the one shown at the top. Others were flattened almost beyond recognition.

Ordinarily, scrapping the lot would be a logical thing to do. Fixtures don't last forever, and these had been used six months in an infiltration process involving a hydrogen atmosphere and 2000° temperatures.

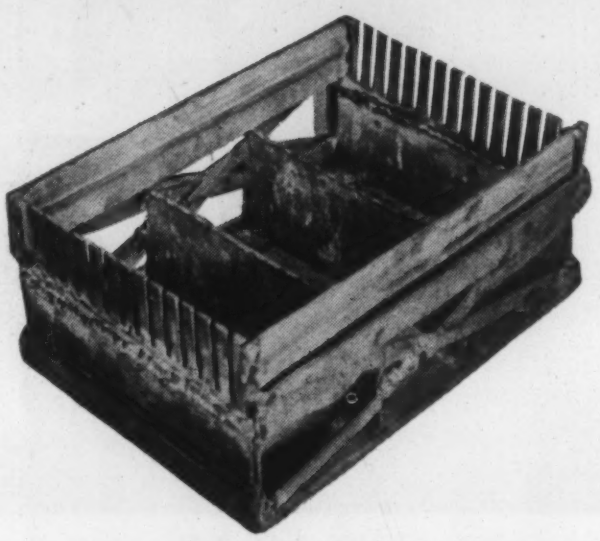
But these were Inconel® fixtures! Despite the severe service they had seen – and the accident that had knocked them flat – they could be repaired. *The metal itself showed no sign of deterioration.*

So back the fixtures went to the ALLOY ENGINEERING COMPANY, of Berea, Ohio, who had designed and fabricated them. They had no difficulty in reconditioning them, and the fixtures are now back in service. The user says they are as good as new.

And the cost? Just 25% of the price of replacement fixtures!

With Inconel, stories of salvage operations like this are not unusual. And neither are remarkable service records. For Inconel is a tough, long-lasting metal that resists corrosion, embrittlement and destructive oxidation at temperatures up to 2200° F.

READY for the scrap pile?



NO! – Repaired and back to work!

In heat-treating service, Inconel fixtures have outlasted others by as much as ten times.

Look over your own heat-treating installations. You may find many places where Inconel can help make substantial long-range savings possible.

It is advisable to place equipment orders with your supplier well in advance of scheduled use. Distributors of Inco Nickel Alloys can supply you with the latest information on availabilities from warehouse and mill.

If you have a special problem, and would like the assistance of our High-Temperature Engineers, ask us to send you a copy of "The High-Temperature Work Sheet." This specially designed form makes it easy for you to describe your individual problem.

Inco Nickel Alloys

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCONEL "W"® • INCOLOY® • NIMONICS®

BASIC MATERIALS CONFERENCE advisory committee, headed by M & M editor T. C. Du Mond (center), is mapping final plans for the June technical meetings which will run concurrently with the first Basic Materials Exposition in New York City. Also shown here are (left to right): Ken Knowles, Clapp & Poliak, Inc.; F. M. Clark, General Electric Co., L. W. Smith, Cornell Aeronautical Laboratory; and J. B. Seastone, Westinghouse Electric Corp.

Materials Show Gains Increasing Support

Dalzell to Speak on Atomic Age Needs; Advisory Group for Conference Picked

Growing interest in the first Basic Materials Conference and Exposition to be held in June in New York City has been noted throughout the manufacturing industries in the past few months.

The widely favorable reaction to the announcement of this new type of national industrial meeting is generally interpreted as demonstrating increasing recognition of the validity of the basic concept underlying the meeting; namely, that proper selection of the material for a product depends on a knowledge of the capabilities of all engineering materials.

Broad Knowledge Needed

In the words of the advisory committee for the conference, headed by T. C. Du Mond, MATERIALS & METHODS editor, "It is no longer sufficient for a product engineer to be a specialist in a single material, be it metals, or plastics, or lumber, or ceramics. He must know the possibilities of each, so that he may substitute when shortages occur and so that he may design products for new uses."

Emphasizing the growing need for a broad understanding of materials is the topic to be discussed at a luncheon session on June 17. Mr. R. Carson Dalzell, chief of metallurgy in AEC's Reactor Development Engineering Div. will speak on "Materials in the Atomic Age", with special attention to the materials problems facing atomic power development.

Other plans for the meeting continue to crystallize. Released recently were the names of the 19-man advisory committee for the technical conference, to be held June 16 to 18 concurrently with the five-day exposition.

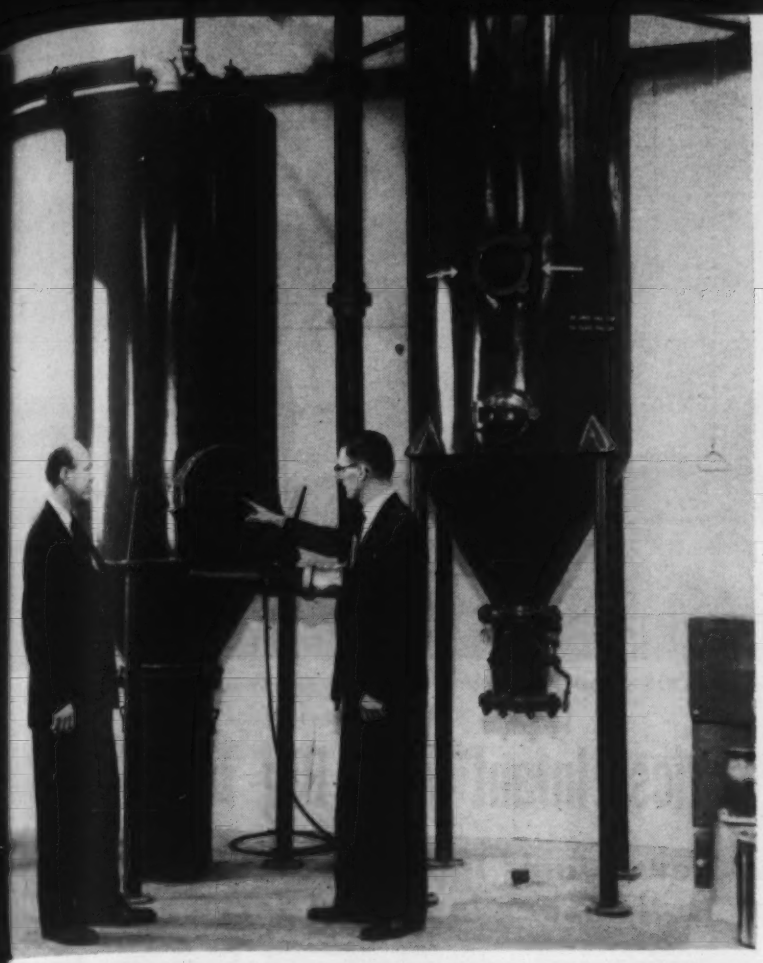
Advisory Committee

They are: Harry S. Blumberg, chief metallurgist, M. W. Kellogg Co., Jersey City, N. J.; F. M. Clark, general engineering laboratory, General Electric Co., Schenectady, N. Y.; N. C. Fick, minerals specialist, Washington, D. C.; Annesta Gardner, technical editor *Modern Industry*, New York; Dr. Zay Jefferies, materials specialist, Pittsfield, Mass.; N. A. Kahn, consulting metallurgist, materials laboratory, N. Y. Naval Shipyard, Brooklyn, N. Y.

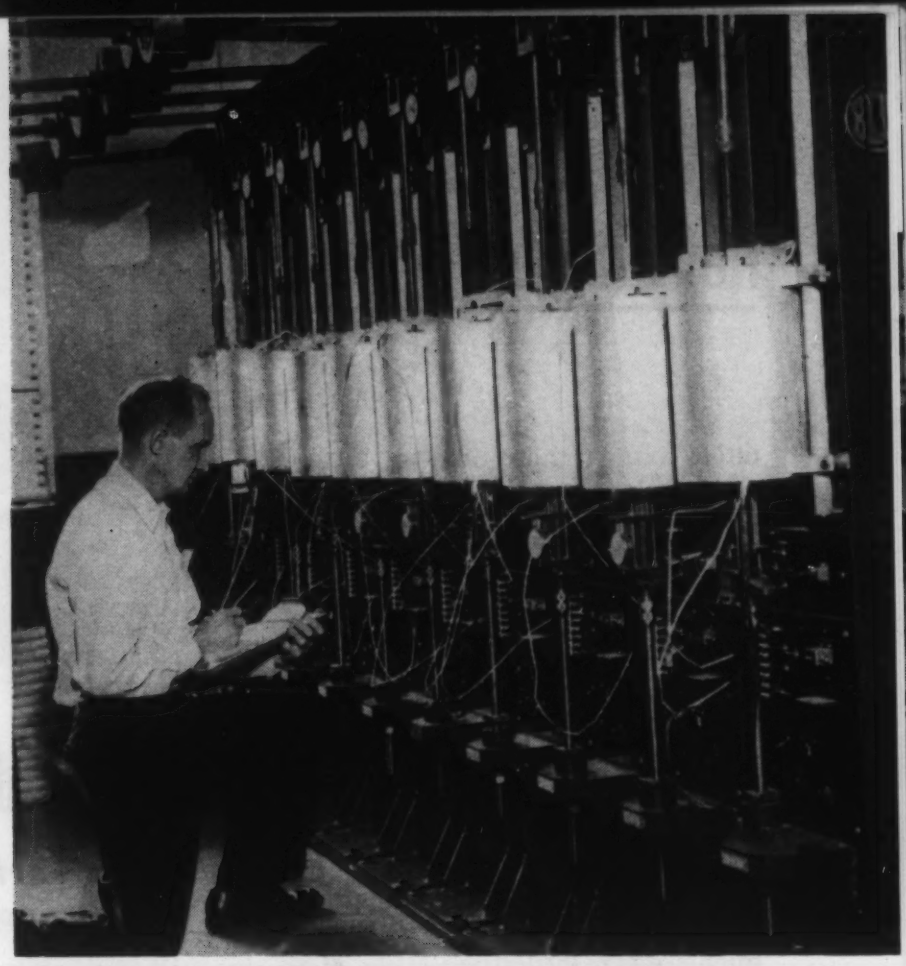
W. E. Kingston, director, Atomic Energy Div., Sylvania Electric Products, Inc., Bayside, N. Y.; H. B Knowlton, chief engineer, materials engineering, International Harvester Co., Chicago; Dr. H. H. Lester, chief, metals research branch, Watertown Arsenal, U. S. Army, Watertown, Mass.; Dr. Clarence Lorig, assistant director, Battelle Memorial Institute, Columbus, Ohio; John L. McCloud, manufacturing research products office, Ford Motor Co., Dearborn, Mich.; Col. B. S. Mesick, commanding officer, Watertown Arsenal, U. S. Army, Watertown, Mass.; Thomas E. Piper, staff eningeer, Guided Missile Div., Consolidated Vultee Aircraft, Pomona, Calif.

William C. Schulte, chief metallurgist, Propeller Div., Curtiss-Wright Corp., Caldwell, N. J.; J. B. Seastone, manager, Materials Div., Westinghouse Electric Corp., East Pittsburgh, Pa.; Loren W. Smith, head, Metallurgy Section, Cornell Aeronautical Laboratory, Buffalo, N. Y.; W. A. Stadtler, manager technical services laboratory, International Business Machines Corp., Poughkeepsie, N. Y.; and J. R. Townsend, director, materials and standards engineering, Sandia Base, Sandia Corp., Albuquerque, N. M.

Advance registration cards for the conference can be obtained from Clapp & Poliak, Inc., 341 Madison Ave., New York 17.



MATERIALS FOR ATOMIC REACTORS which would allow them to operate at higher power levels is the goal of development work now in progress at the Hicksville, L. I., plant (part of which is shown above) of the Atomic Energy Div. of Sylvania Electric Products, Inc. Such materials must remain structurally sound at high temperatures and under intense bombardment by atomic radiation.



HIGH TEMPERATURE CREEP characteristics of nickel alloys are being determined continuously in International Nickel's Huntington, W. Va., plant. More than 40 creep machines apply loads ranging from 2800 to 100,000 psi at temperatures of 700 to 1800 F and for times up to three years or more. (Courtesy Baldwin-Lima-Hamilton Corp.)

Materials Supply—Its Ups and Downs

A Round-Up of Production, Consumption; Fabricators Find Steel Plate Shortage

Fabricators of heavy metal tanks say they are not getting enough steel plate to operate anywhere near capacity.

The Heavy Metal Tanks Industry Advisory Committee told officials of the National Production Authority recently that the demand for heavy quality plate has been growing steadily, but steel producers are reluctant to expand such rolling facilities because heavy quality plate is not as profitable as other types of steel.

Committee members said a critical shortage of heavy plate would prevail if a full-scale war should break out. This criticism has been leveled at the steel industry previously but has been met with the assertion that many sheet rolling facilities could be converted to plate if the need became critical.

The Heavy Metal Tank Committee recommended that the President's Defense Mobilization Board look into the problem of heavy plate production and that the Army Corps of Engineers and the Navy "cease overwriting their specifications for heavy quality plate."

The Committee disagreed with an NPA surmise that the supply of such plate would soften by the end of the second quarter.

Tank fabricators were not the only manufacturers having difficulty finding enough steel plate. A few weeks earlier a similar complaint had been entered by manufacturers of tubular heat exchangers who were also short on seamless steel pipe.

More Aluminum Capacity . . .

End of the 200,000-ton third-round expansion of aluminum capacity is now in sight.

Negotiations now underway between the National Production Authority and The Wheland Co., of Chattanooga, Tenn., are expected to result in a new entry in the aluminum field with a capacity not less than 50,000 tons a year.

On top of previous third-round

(Continued on page 170)

New SAE Boron Steels

Four new boron steels, alternates to the 41XX series of standard steels, have been approved by the Iron and Steel Technical Committee of the Society of Automotive Engineers.

Designated 42B35, 42B40, 42B45 and 42B50, these steels have carbon limits of 0.32 to 0.37, 0.37 to 0.45, 0.42 to 0.50 and 0.47 to 0.55% respectively. Other composition limits are 0.70 to 1.00 manganese, 0.20 to 0.35 silicon, 0.40 to 0.65 chomium and 0.08 to 0.15% molybdenum.

These compositions, generally available hot rolled or as tube, wire or cold finished bars, were developed to conserve nickel and molybdenum.

Also approved recently by the SAE was AISI 1345, a standard manganese steel.

For Bouncier Walk: Rubber

Rubber, that useful and versatile material, has bounced itself right into an entirely new and surprising application. A moving rubber sidewalk,

(Continued on page 8)

News Digest

68 ft long, is now carrying throngs of people through part of B. F. Goodrich's "Story of Rubber" exhibit in Chicago's Museum of Science and Industry.

Speculating on the future, John L. Collyer, B. F. Goodrich president, said that, coupled with escalators, "this mode of travel is a practical means of transporting rapidly and efficiently vast numbers of people in crowded areas.

"Indoor sidewalks also have possibilities for use in large buildings such as airline, bus and railroad terminals where pedestrian traffic is exceptionally heavy," he added.

The exhibit sidewalk is constructed of fabric and rubber, the bottom ply being designed to afford high sliding abrasion resistance. It is capable of transporting 5000 people an hour.

KAISER-FRASER'S PLASTICS-BODY sports car, scheduled for mid-summer production.

Reinforced Plastics: Infant with Big Ideas

Overflow Crowd Jams Industry Meeting; Broad Application Seen in Armed Services

The fastest growing new material today is reinforced plastics.

True, it is still "small business" from the standpoint of total volume, but no other engineering material today stands on the threshold of so many new applications.

This appraisal is supported not only by statistics of the plastics industry but by the increasingly tangible interest of leading manufacturing industries, not to mention the armed forces. A convincing demonstration of the weight taken on by this lusty infant in just one year was to be found in the February meeting of the Society of the Plastic Industry's Reinforced Plastics Div. held in Washington, D. C.

Conference Jammed

Prepared for a group of about 900 (which would have represented a considerable increase over the previous year), the conference had to cope with an overflow crowd of 1420 who jammed the Shoreham Hotel to tour the special exhibit, sit in on the technical forums and talk business with suppliers and customers. Of the 437 different companies represented, 56% were not members of SPI. Many of

(*Continued on page 184*)

What They Said....

PLASTICS "Either we (plastics) are being condemned as a cheap substitute, or there is being ascribed to us some revolutionary development the impracticality of which is only exceeded by the exaggerated terms in which it is described. The public has not yet been able to accept our plastics with the same calm philosophy it has used for many generations in the case of the ancient natural materials.—*Gordon Brown, president, The Society of the Plastics Industry, Inc., Feb. 19, 1953.*

NICKEL USE "In the present emergency, when the free world has need for every pound of its various metals, the Company's resources in research and technical knowledge have been equally valuable in promoting the most efficient use of every pound of its production and, when technically possible, the use of alloys of lower nickel content and even materials containing no nickel. . . . Nickel should be used only in those places where it renders a service that justifies the cost. . . . Many high-nickel alloys for which substitutes have been temporarily adopted will return to their normal uses after today's emergency."—*Dr. John F. Thompson, chairman of the board, The International Nickel Co., Inc., Nov. 13, 1952.*

TECHNICAL COOPERATION "The success of any Atlantic confederation necessarily relies to a great extent on the cooperation of its scientific and engineering personnel."—*Willis R. Woolrich, Dean, University of Texas, Feb. 9, 1953.*

STEEL SUPPLY "In 1943, the year in which the largest tonnage of our steel went into direct war needs, these requirements took less than 33 million tons of ingots and over half of that tonnage went into ships and defense plants rather than armaments. In that year we used 38% of our steel for these purposes. Today, because of the great growth of the industry since the end of the war, we could, if necessary, put 50% of our steel into direct war needs and still have more left over for other essential requirements than we had in 1943."—*Joseph L. Block, executive vice president, Inland Steel Co., Feb. 16, 1953.*

Plastics Autos and Airplanes?

Time will tell, but one thing is certain: it is no longer a joke. Designers in both of these important industries are taking a serious look at the rapidly expanding field of reinforced plastics.

For details on the outlook for reinforced plastics in these two important fields, see the articles in this issue, p 190 (Auto Bodies) and p 198 (Airframes).

News Digest

Briefs

FISSION REVERSED Aluminum is one of the elements which have been formed by nuclear combination of lighter elements in experiments conducted at Oak Ridge National Laboratory. This process represents the opposite of nuclear fission, which breaks heavier elements into lighter ones.

SPENT MATERIALS In support of its high standard of living, the U. S. uses up more than 2½ billion tons of materials every year—an average of 18 tons of material for each person in the country.

FALSE TEETH Some hope of keeping false teeth firmly in place is offered by a new magnetic technique making use of tiny, powerful platinum-cobalt alloy magnets. Embedded within the bones of the mouth cavity by oral surgery, these magnets act on similar ones in the denture and thus hold the plates securely.

STAINLESS SURGERY Thin, pliable fabrics of stainless steel are used as nonirritating "blow-out" patches in the repair of hernias. Tantalum and glass fabrics are also used.

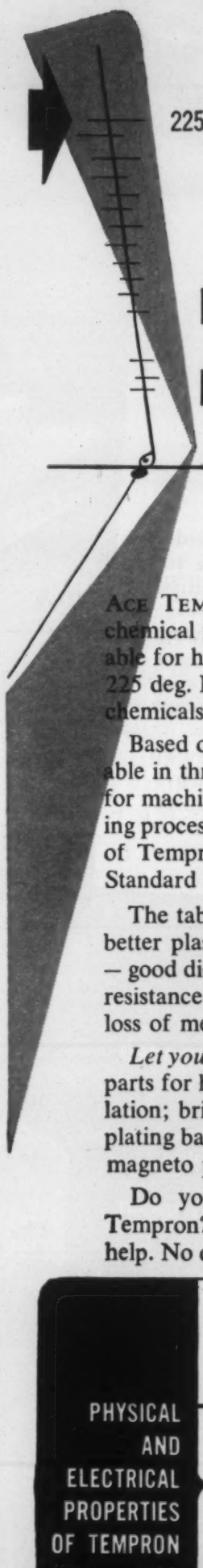
WEIGHT SAVING Use of aluminum construction and silicone insulation has enabled one manufacturer to slash the weight of a special 100-kw generator for aircraft from 2000 lb down to 1215 lb.

PLASTICS PIPE The American Gas Assn. has set up a committee to develop standards for plastics pipe, tubing and fittings.

STEEL CAPACITY Last year's gain of about 8,960,000 tons in steel capacity is the largest such gain ever made in one year. Capacity has increased about 30% in seven postwar years.

INSULATION Closely woven glass yarn and Teflon are being fused in a special process by Packard Electric Div. of GM to produce insulation that enables low-tension aircraft ignition cable to withstand abrasion and temperatures as high as 500 F.

(*More News Digest on page 205*)



Now!

HARD RUBBER PARTS FOR HIGH TEMPERATURES

...ace tempron®

ACE TEMPRON, a new synthetic hard rubber, now makes the chemical resistance, strength, and economy of hard rubber available for high-temperature applications! It is stable and rigid up to 225 deg. F. and higher, and shows remarkable resistance to many chemicals when tested at 200 deg. F.

Based on nitrile synthetic rubber (Buna-N), Tempron is available in three forms: (1) Molded parts, (2) sheet, rod and tubes, for machining a wide variety of shapes; and, (3) a hand-fabricating process for making tanks, large fittings, etc., by forming sheets of Tempron around cores or mandrels prior to vulcanization. Standard pipe and fittings are also made.

The table below tells the story – high tensile on a par with the better plastics – a chance to save weight – good impact strength – good dielectric properties – excellent chemical, oil and moisture resistance – and ability to withstand high temperatures without loss of mechanical strength.

Let your imagination loose on these typical applications: molded parts for hot jobs; special fittings for corrosives; transformer insulation; brine and gasoline meter parts; trays for vacuum dryers; plating barrels; hot brine systems; tubing for electrical condensers, magneto parts.

Do you make anything that might be improved by Ace Tempron? Why not look into it? Let us know and we'll be glad to help. No obligation, of course.

PHYSICAL AND ELECTRICAL PROPERTIES OF TEMPRON

PROPERTIES	MOLDED PARTS, SHEET, ROD & TUBES	HAND-BUILT PRODUCTS
Tensile Str., psi.	7170	7500
Elongation, %	2.70	2.80
Specific Gravity	1.24	1.25
Hardness—Durometer D	87	87
Impact, ft.—lbs./in.	0.41	0.49
Flexural Str., psi.	11,300	11,800
Dielectric Str., v/mil, 60 cyc.	400	460
Power Factor, 1 kc.	0.016	0.016
Dielectric Constant, 1 kc.	3.50	3.70
Water Absorption, (48 hrs. R.T.%)	0.12	—
Heat Distortion Temp., deg. F.	275	260

ACE® rubber and plastic products

AMERICAN HARD RUBBER COMPANY
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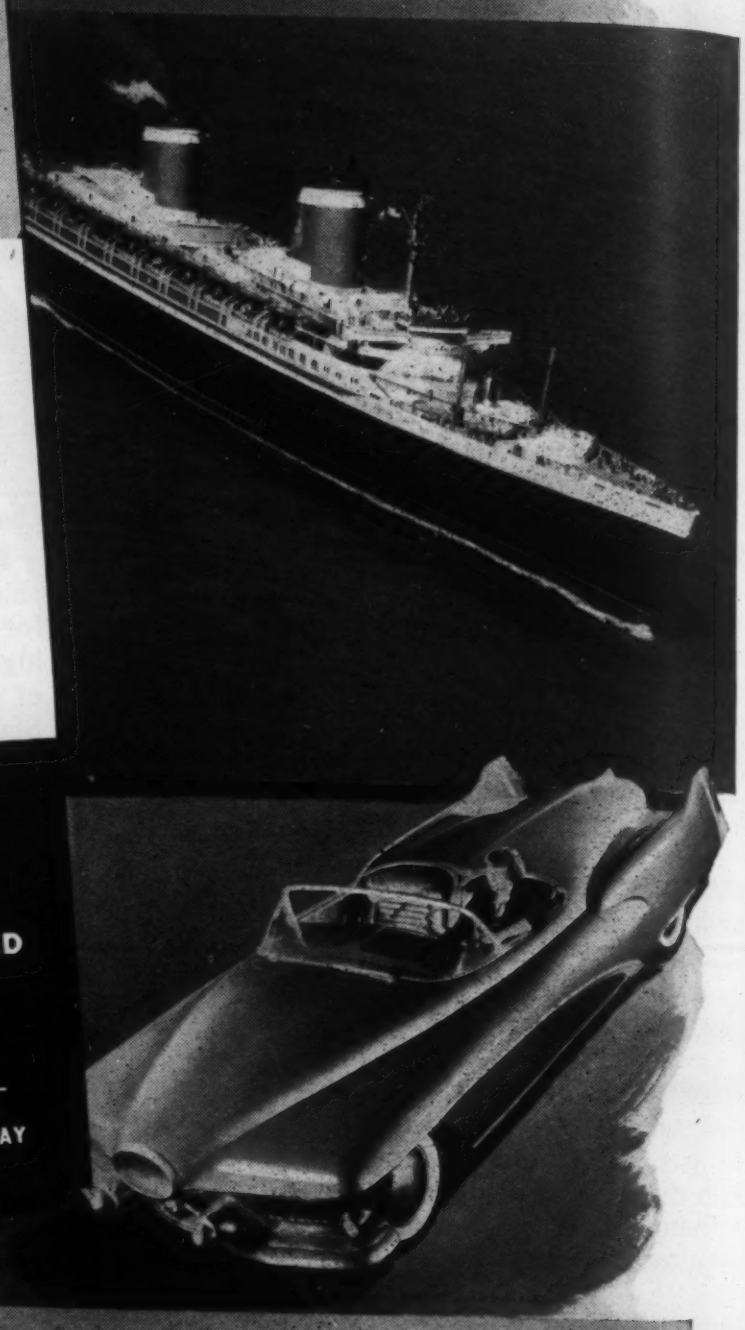

REVERE ALUMINUM

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Preview

1953 Metal Powder Show

Ninth Annual MPA Meeting

"Progress in Powder Metallurgy" is the theme of the 1953 Metal Powder Show, to be held Apr. 21 and 22 in Cleveland at the Hotel Cleveland. The exhibit will run concurrently with the ninth annual meeting of the Metal Powder Assn. and is sponsored by that group.

The show will feature new products made from metal powders and the latest developments of leading producers of metal powders and fabricating equipment. The displays will be located in the Red Room and Red Room Foyer, mezzanine floor, and will be open from 9 A.M. to 7 P.M. Tuesday and from 9 A.M. to 5 P.M. Wednesday.

As suggested by the theme selected for this year's show, the emphasis in the technical sessions will be on a review of the progress made in powder metallurgy and the outlook for the future.

Three technical sessions will be held. The first meeting will start at 10 A.M. Tuesday and will be headed by W. E. Cairnes, Radio Cores, Inc. The second session, at 2:30 P.M., will have E. H. Klein, The New Jersey Zinc Co., as its chairman. T. R. Moore, Antara Chemicals Div. of General Dyestuff Corp., will be chairman of the third technical session, to be held at 10 A.M. Wednesday. All technical sessions will be held in the Ballroom.

Topics to be covered in the technical sessions include: design trends in iron core coils, metal powder friction materials in heavy duty transmissions, tailor-made alloy powder parts, nonmetallic impregnation of metal powder parts, processing in the higher density range of durable precision iron powder parts on a production basis, availability of iron powder, comparison of brass with other metal powders, aluminum powder metallurgy, and a progress report on the NBS permeameter.

The final paper, entitled "Powder Metallurgy at the Cross Roads—Present and Future Possibilities," will summarize the present status of the field and point out those applications which seem to offer the most promising potential market for powder metal parts.

Two social occasions are scheduled. A reception, including cocktails and buffet supper, will be held at 5:30 P.M. Tuesday following the second technical session. Cocktails at 12:30 and luncheon at 1:00 P.M. will follow the final technical session on Wednesday. Speaker at the luncheon will be Dr. Joseph Zimmerman, Editor, *Daily Metal Reporter*, who will talk on "The Current Outlook for Metals."

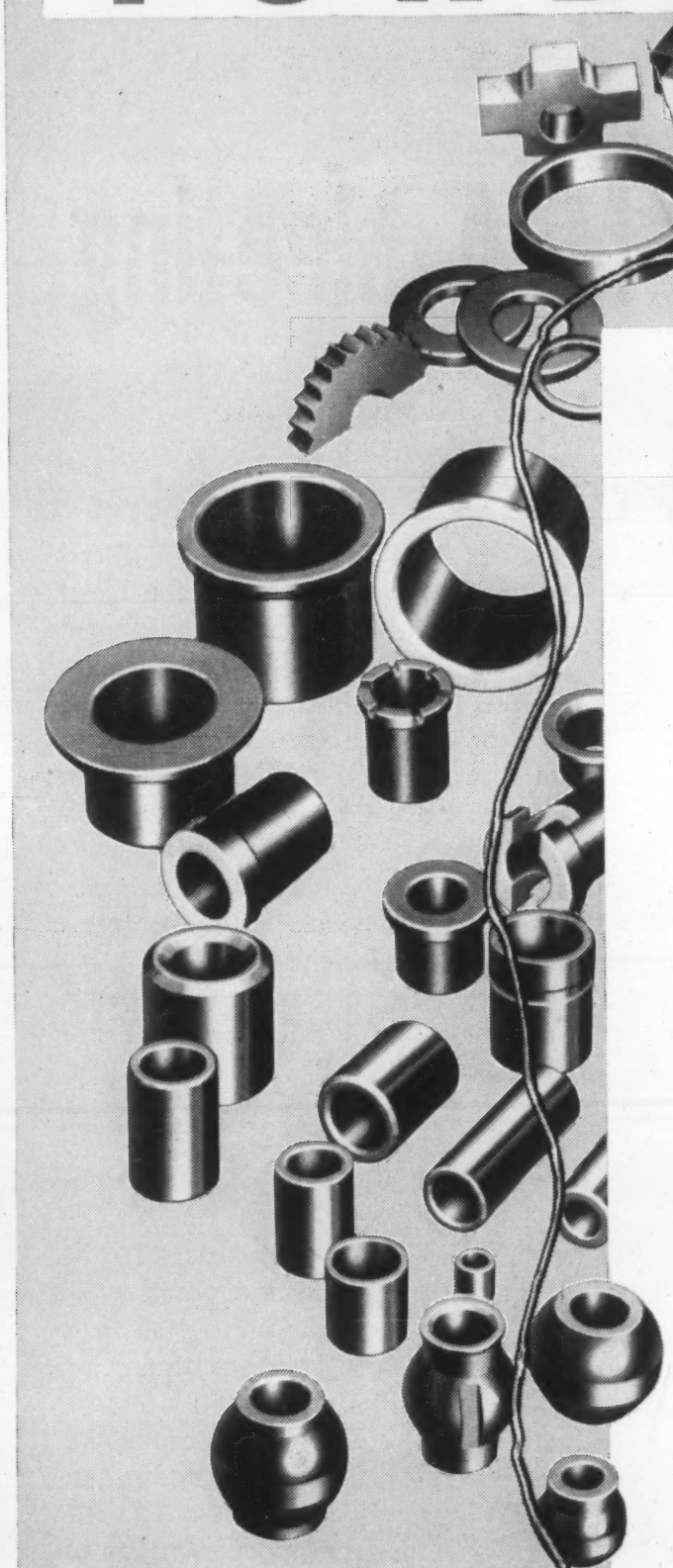
Powder metallurgy standards committees will be active both before and after the open technical sessions. Standards committees of MPA and ASTM (B-9) will meet at 10 A.M. Monday, Apr. 20, and again at 2:30 P.M. Wednesday, Apr. 22, following the luncheon meeting.

A detailed program of the meeting, including short abstracts of the technical papers and a list of exhibitors for the Show, is given on the following pages.

JOHNSON

POWDER METAL

BEARINGS AND PARTS



for certain applications nothing can beat them

The porous structure of Johnson Ledaloyl bearings and parts permits oil impregnation during manufacture, making them self-lubricating. In operation, the oil is metered to the shaft and reabsorbed when the shaft is at rest. Should your specific application be difficult or impossible to lubricate regularly, here is your answer.

Other industrial uses are: Self-alignment, low-cost bearings or special parts, applications where heavy duty service is not a factor. Ledaloyl bearings and parts are pressure molded to shape and size . . . no machining necessary . . . hence their low unit cost in large quantities. In numerous applications they give long, troublefree service. Johnson engineers will gladly help you determine whether you can use Ledaloyl bearings or parts. Write for an appointment.

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769 South Mill Street • New Castle, Pa.

Ledaloyl
SELF-LUBRICATING

POPULAR sizes of straight, flanged and self-aligning bearings are available from stock. Write for catalog.

JOHNSON JB BEARINGS
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JOHNSON BRONZE PRODUCES ALL TYPES OF SLEEVE BEARINGS: BRONZE-ON-STEEL, copper lead • STEEL BACK, babbitt lined • BRONZE BACK, babbitt lined • CAST BRONZE, plain or graphited • SHEET BRONZE, plain or graphited • CAST ALUMINUM ALLOY • ALUMINUM-ON-STEEL.

 (continued from page 15)

Program

All meetings and other events, unless otherwise noted, will be held in the Ballroom of the Hotel Cleveland.

Tuesday, April 21

9:00

Registration on mezzanine floor. Exhibit opens in Red Room and Red Room Foyer, mezzanine floor. Exhibit closes 7 P.M.

Morning Session

Chairman: W. E. Cairness, Radio Cores, Inc.

10:00

THE PROCESSING IN THE HIGHER DENSITY RANGE OF DURABLE PRECISION IRON POWDER PARTS ON A PRODUCTION BASIS—*W. J. Doelker and H. T. Harrison, National Cash Register Co.*

Development of metal powder parts applications at the National Cash Register Co., types of powders required, physical properties and heat treatment of the products, dimensional and surface finish limits, production rates, types of tools, tool life and specific applications and problems.

10:45

A PROGRESS REPORT ON THE NBS PERMEAMETER—*G. P. McKnight, Speer Resistor Div., Speer Carbon Co.*

The principal of operation of the NBS radio frequency permeameter, a modification to extend its range to about 35 megacycles, and a simple graphical method of studying dissipation factor. Curves illustrate types of information obtainable.

11:15

DESIGN TRENDS IN IRON CORE COILS—*Bernard Goldsmith, Essex Electronics.*

Latest trends in applications of iron cores in coil components for electronic equipment. Effects of new materials and techniques and future outlook for the industry.

Afternoon Session

Chairman: E. H. Klein, The New Jersey Zinc Co.

2:30

METAL POWDER FRICTION MATERIALS IN HEAVY DUTY TRANSMISSION — *J. E. Storer, Allison Div., General Motors Corp.*

Latest developments in clutch plate applications of metal powder friction materials, comparative performance data and possible military applications.

3:15

A SURVEY OF THE IRON POWDER SITUATION — *R. L. Ziegfeld, Metal Powder Assn.*

Results of survey to determine what the real iron powder supply picture is and what potential capacity exists for production of iron powders for both civilian and special military applications.

4:00

ALLOY POWDERS BY THE HYDRIDE PROCESS—*B. A. Gruber, Metal Hydrides, Inc.*

Report on work completed and contemplated on the production of tailor-made metal powder parts having given properties, *i.e.*, strength, corrosion, refractory, etc., utilizing titanium, zirconium, nickel, chromium and other powders and their alloys.

4:45

A PROGRESS REPORT ON BRASS—*D. C. Bradley, The New Jersey Zinc Co. and W. R. Toeplitz, Bound Brook Oil-less Bearing Co.*

A comparison is made between brass and other sintered materials showing some of the advantages and disadvantages encountered in fabricating parts from brass and three other metal powders.

Evening Reception

5:30

Reception, including cocktails and buffet supper.

Wednesday, April 22

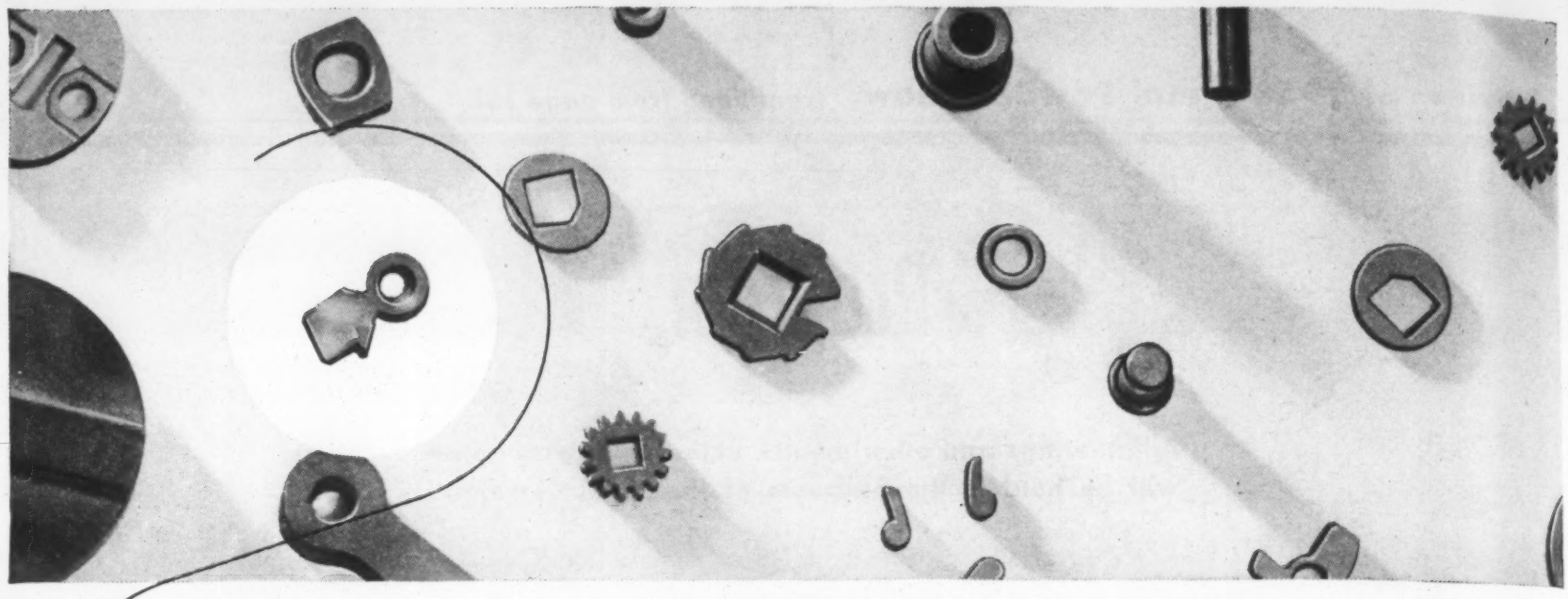
9:00

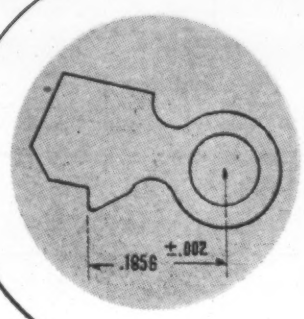
Exhibit opens in Red Room and Red Room Foyer, mezzanine floor. Exhibit closes 5 P.M.

Morning Session

Chairman: T. R. Moore, Antara Chemicals Div., General Dyestuff Corp.

(*Continued on page 19*)





A group of parts, shown in actual size, made from powder metal at National Cash Register Company. Encircled is the business machine counter re-set pawl which is described in the accompanying text.

Need close-tolerance parts . . . in great quantity . . . at low cost?

Make them of powder metal! Many close tolerance parts, including counter re-set pawls for business machines, are made in one operation by powder metallurgy at the National Cash Register plant in Dayton, Ohio. Variation from specification on the pawls — in some dimensions as close as ±.002 inches — is less in powdered metal than in pieces formerly stamped, shaved and tumbled. Milling operations are eliminated . . . production increased . . . materials saved by eliminating strip scrap.

Powder metal production is *fast* . . . wastes no materials, makes pieces which are impossible or too costly by the usual metal-working methods . . . mechanical strength is comparable with that of machined parts.

Powder metal parts can be "tailored" for tensile strength, hardness, ductility, corrosion resistance, self-lubrication, controlled porosity, or a combination of these factors. Parts with irregular contours or complex profiles, or those imposing severe cutting-waste in their machining, are made in powder metal at savings of 50% to 80%.

Stokes has been building a wide variety of powder metal presses for over 30 years . . . in capacities to apply from 2½ tons to 100 tons pressure. Whatever your requirements, Stokes has the press and engineering "know-how" to help you produce the best part possible with minimum labor and maximum saving.

Send for the free brochure "Powder Metallurgy Today"; send parts, or blueprints of parts, to the Stokes Advisory Service for study and cost analysis.

F. J. Stokes
Machine Company,
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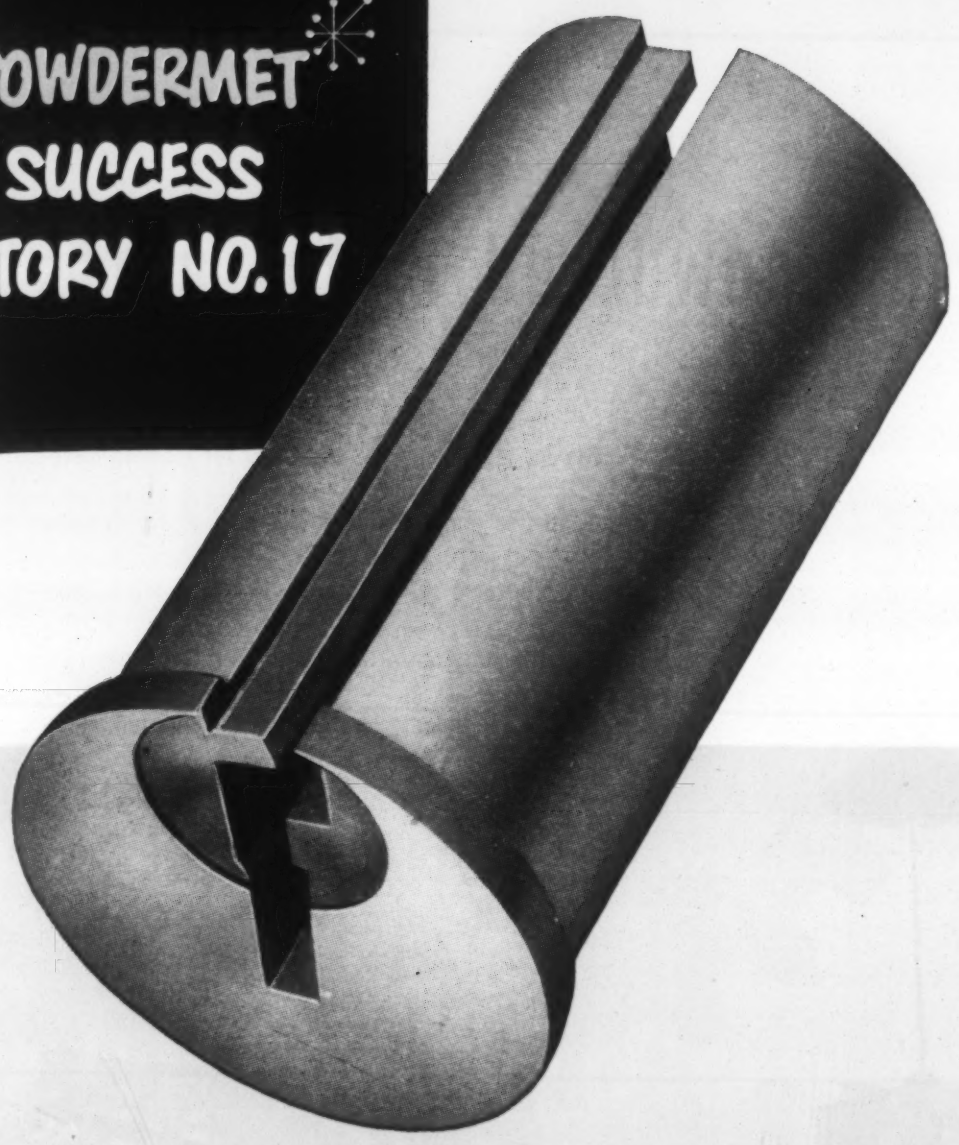
STOKES MAKES: High Vacuum Equipment, Vacuum Pumps and Gages / Industrial Tabletting, Powder Metal and Plastics Molding Presses / Pharmaceutical Equipment

POWDERMET SUCCESS STORY NO. 17



HOLDING LOCK PLUG TOLERANCES TO ±.0005"!

Formerly the manufacturer had to broach these small lock plugs in order to hold a tolerance of plus or minus .0005". Naturally the machining operation was costly and time-consuming. It was obviously desirable to use powdered metal but because of the extremely close tolerances it was considered unworkable.

Then they came to Powdered Metal Products Corporation of America and discovered PMP could supply plugs to the required tolerances and still substantially lower the cost. There was no sacrifice of quality or wear characteristics. In fact the PMP plug withstands repeated tests of over 500,000 cycles—much more than encountered in normal use.

If you have a problem involving production parts, why not consult Powdered Metal Products? Their complete facilities assure finest results.

Write today for complete information.

sign of leadership PMP in powder metallurgy

POWDERED METAL PRODUCTS CORPORATION of America

9335 West Belmont Avenue,
Franklin Park, Illinois

*Trademark

MPA Show....

continued from page 17

10:00

THE NONMETALLIC IMPREGNATION OF SINTERINGS—*W. N. Pratt, American Metaseal Manufacturing Corp.*

Procedures and methods of impregnation of metal powder parts using thermosetting resins which result in pressure tight parts and the elimination of finishing problems.

10:45

REVIEW OF ALUMINUM POWDER METALLURGY—*J. Haertlein and J. F. Sachse, Metals Disintegrating Co., Inc.*

Production and uses of aluminum powders and proposed methods for overcoming the difficulties encountered in pressing and sintering aluminum. Latest developments in sintered aluminum powders (SAP) and economic potentialities of aluminum powder parts applications.

11:30

POWDER METALLURGY AT THE CROSS-ROADS — PRESENT AND FUTURE POSSIBILITIES—*J. D. Shaw, S-K-C Research Associates.*

Present status of powder metallurgy, based on 20 years of progress. Cost data and specific cases show the potential market for powder metallurgy applications, markets that have been overlooked and those that are not progressing.

Luncheon

12:30

Cocktails.

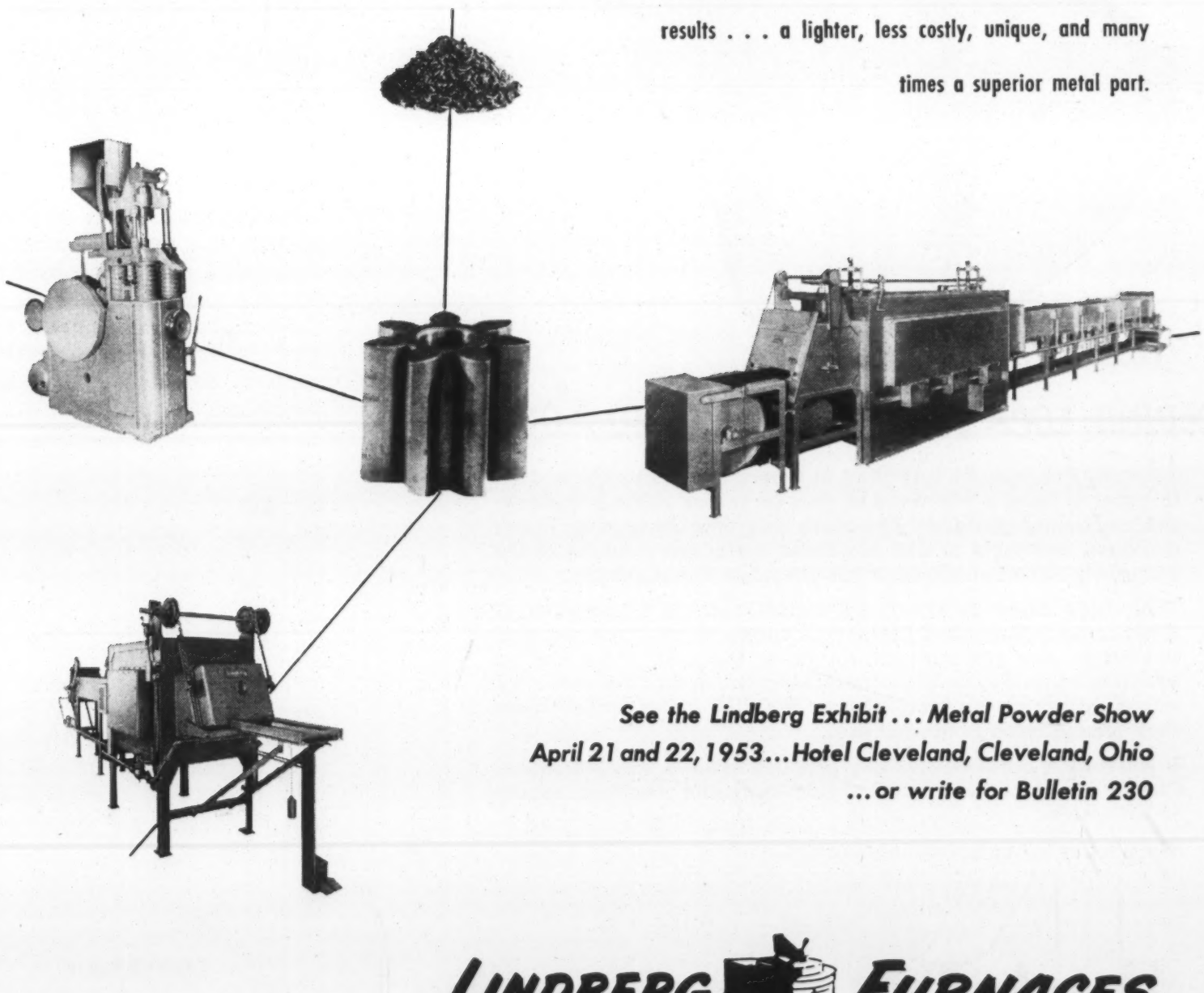
1:00

Luncheon. Speaker: Dr. Joseph Zimmerman, Editor, *Daily Metal Reporter,* on "The Current Outlook for Metals."

(*Continued on page 21*)

sintering powdered metal parts

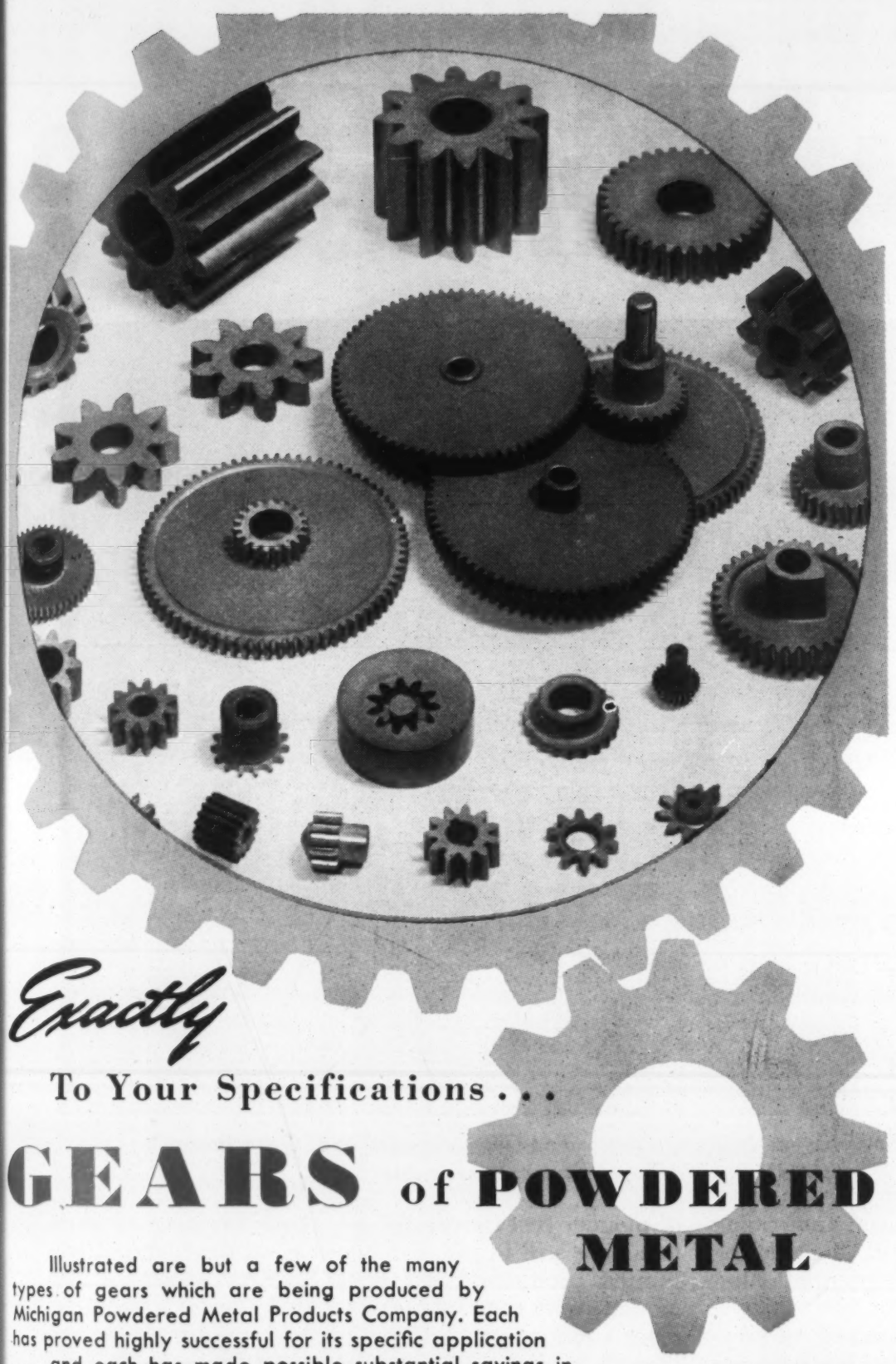
Powder metallurgy . . . a process for forming metal parts from fine metal powders. Mix a quantity of metal powder with lubricants . . . compress to shape . . . sinter "green" briquette in furnace . . . size or coin if necessary . . . results . . . a lighter, less costly, unique, and many times a superior metal part.



See the Lindberg Exhibit . . . Metal Powder Show
April 21 and 22, 1953 . . . Hotel Cleveland, Cleveland, Ohio
. . . or write for Bulletin 230

LINDBERG FURNACES

Lindberg Engineering Company,
2450 West Hubbard Street, Chicago 12, Illinois



Exactly

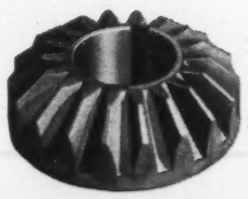
To Your Specifications . . .

GEARS of POWDERED METAL

Illustrated are but a few of the many types of gears which are being produced by Michigan Powdered Metal Products Company. Each has proved highly successful for its specific application . . . and each has made possible substantial savings in the cost of assembled finished products.

As one of the pioneers in the field of powder metallurgy, this company has been responsible for the development of many of the most advanced methods of producing powdered metal parts of all kinds. In the processes employed here, there is the most accurate control of density, porosity, dimensional tolerances and surface finish. When required, strength equivalent to that of mild steel can be provided—an important factor in gear production in particular.

If you need gears or other parts in high volume . . . if you're interested in the savings effected by elimination of machining and finishing operations . . . and if you want your specifications to be met *exactly*, it will pay you to learn what we can do for you. Send us your part prints for a quotation.



BEVEL GEARS

Now available on contract basis in sizes up to approx. 4 in. O.D. In bevel rings, larger sizes can be supplied. Write for full details.

MICHIGAN POWDERED METAL PRODUCTS COMPANY, INC.

476 CADY STREET • NORTHVILLE, MICH.

Subsidiary of

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MPA Show....

continued from page 19

List of Exhibitors

Exhibitor	Booth No.
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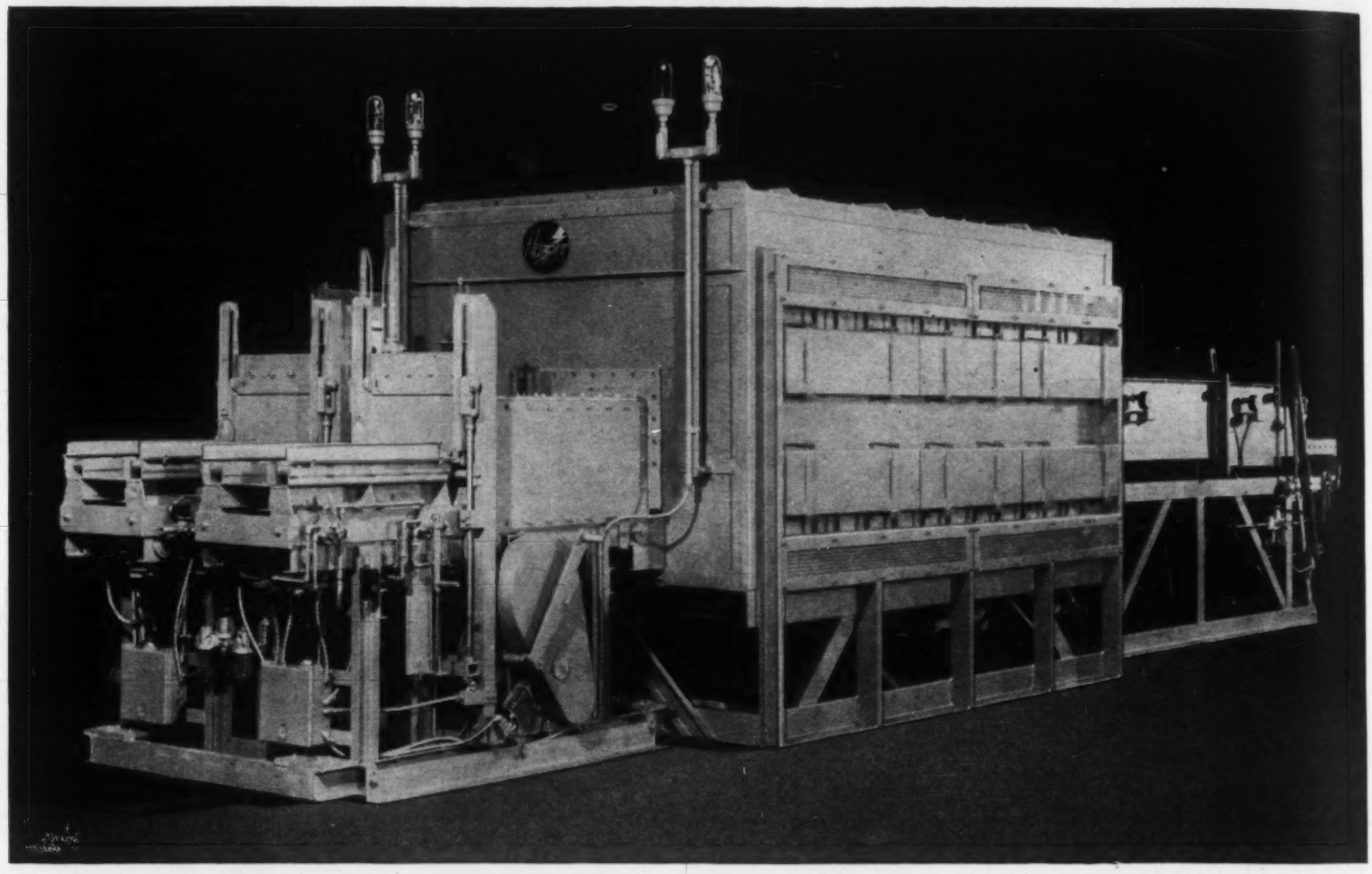
Harper WHAT will they name it ?



Our Pioneer Research Furnaces for Sintering and Infiltration were called "Flamethrowers" and "Green Dragon". What will this newest Harper Furnace be nicknamed?

● Here is the latest Harper Sintering and Infiltrating Furnace to leave our plant, designed with outstanding features to help our customers obtain high production on a continuous trouble-free basis.

Better furnaces for sintering and infiltrating of powder metal parts have been Harper Engineer's problem since powder metallurgy began. They designed and built many research furnaces which served the purpose of pioneer research sintering. These furnaces of which many are still in use, produce a good product, but give limited production and have features which are outmoded. With the rapid expansion of powder metallurgy, plant production facilities are becoming crowded and there is a need for a rugged compact furnace which will satisfy the demand for greater production, yet will fit into limited plant space.

✸ **Harper Engineers have solved this problem with a rugged, double muffle continuous pusher type furnace such as shown above. This furnace will heat treat heavy concentrated loads stacked on sturdy alloy trays, which are beyond the capacity of conveyor belt and roller hearth furnaces. Because of its double muffle it does the work of two furnaces or one furnace twice as long, yet occupies less space. Charging and discharging of materials is simplified with end loading. It is ruggedly built and will operate continuously with less maintenance and down time.**

The above furnace was designed for one of our customers for sintering and infiltrating of special jet engine parts. It might not suit your production requirements, however if you will write, stating your heat treating problem, mentioning the size, weight and quantity of product, maximum temperature, heating schedule and available current characteristics, Harper Engineers will be glad to recommend and quote on your requirements.

HARPER ELECTRIC FURNACE CORPORATION

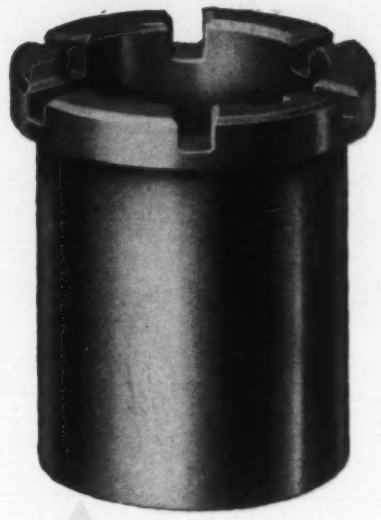
DEPT. 6, 39 RIVER STREET • BUFFALO 2, NEW YORK

McCormick cotton picker uses

GRAMIX® bearings

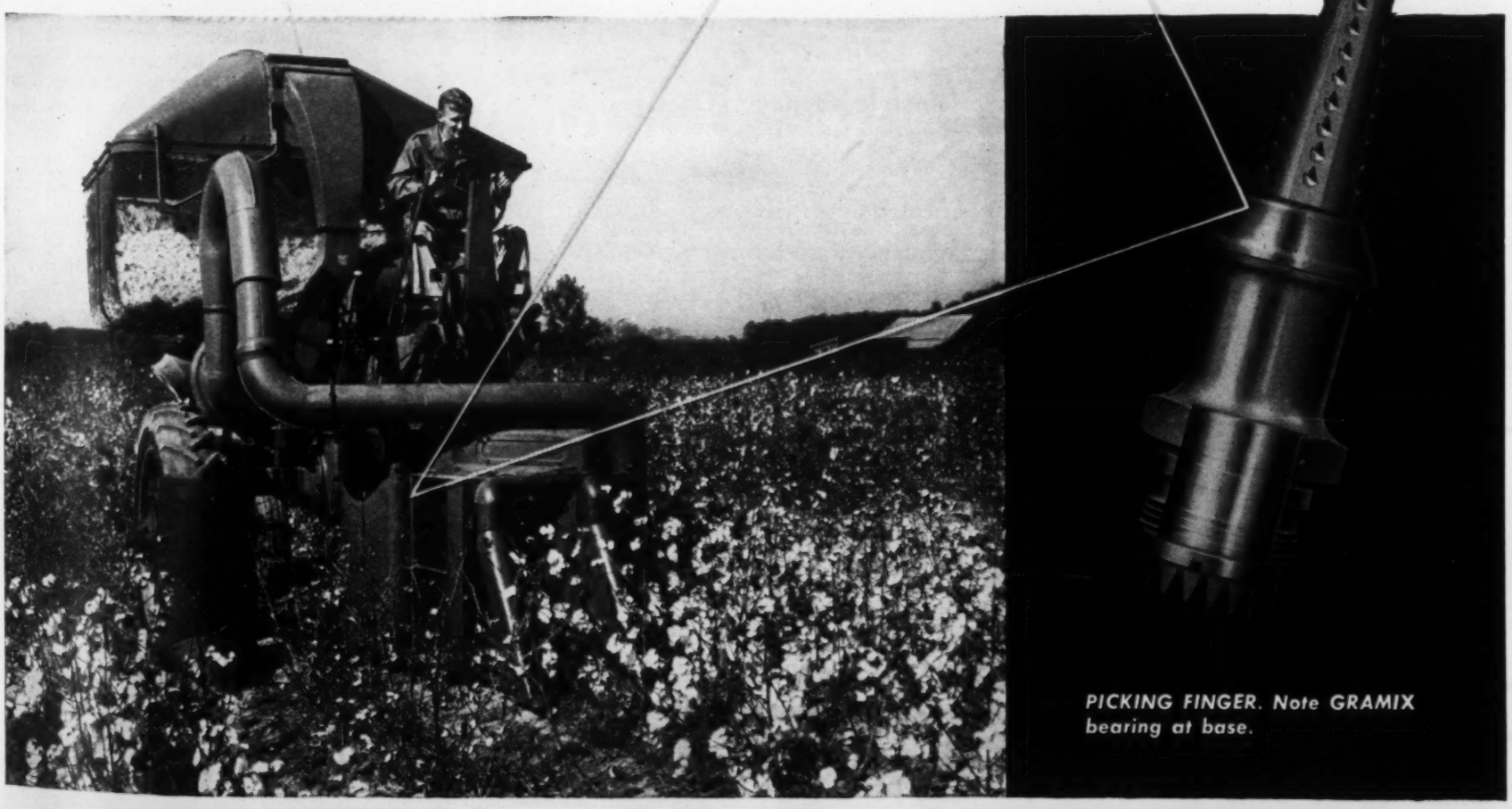
As one of International Harvester's big high-drum type McCormick Cotton Pickers moves down a row of cotton, 600 barbed picking fingers, rotating at speeds up to 2700 r.p.m.'s, pluck the cotton from the open bolls. And bronze GRAMIX bearings, on the barbed fingers, help make the successful operation of this ingenious picking device possible. This is typical of the way GRAMIX parts have helped improve many products and made the development of many other products possible. GRAMIX is produced from metal powders, compacted under pressures up to 70,000 psi and sintered at high temperatures to form strong, tough alloyed metal parts that will usually outperform and outlast parts produced by old fashioned machining methods. GRAMIX bearings and other specialty parts can be die-pressed into fairly intricate shapes with tolerances as close as .0005". They require little or no machining, thus saving man-hours of production time and greatly reducing scrap loss and waste. Because of their porous structure, GRAMIX parts require less metal and they can be oil-impregnated during manufacture to insure a constant oil film at the bearing surface.

It's now ready! Our new 44 page catalog in full color. Write us for your copy today.



GRAMIX bearings like this help the barbed fingers of the picking unit operate so efficiently in the amazing McCormick Cotton Picker.

95



PICKING FINGER. Note GRAMIX bearing at base.

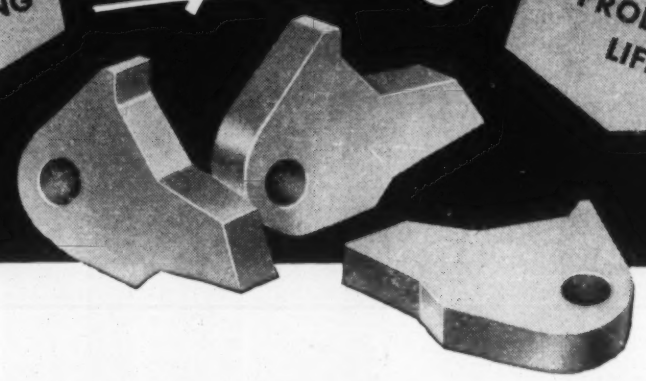
THE UNITED STATES GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION • SAGINAW, MICHIGAN

ELECTROLYTIC IRON SINTERINGS *replace alloy castings*

• ELIMINATE COSTLY MACHINING

• INCREASE PRODUCT LIFE



Electrolytic iron powder, produced by Plastic Metals, is now being used by Presmet Corporation, Worcester, Mass., for making impeller blades for the flywheel of the Westinghouse "Waste-Away" garbage disposer.

Formerly these double-edged blades were high-carbon, high chromium alloy steel castings which required annealing and six expensive machining operations. The part, as designed, was perfect for compacting, its uniform thickness presenting no difficult tooling or pressing problems.

Electrolytic iron powder, chosen because of its superior properties, is compacted, sintered and then infiltrated with a copper alloy in a controlled atmosphere electric furnace. Costly machining operations are completely eliminated.

As a practical wear test—after three months continuous operation in a cafeteria waste disposing unit (where waste from some 1200 meals per day are disposed of in this equipment), the metal powder impellers were found to be in excellent condition.

You may have a product where the use of a metal powder part will result in a similar production cost saving . . . or where scarcity of metals may now be holding up production. We shall be glad to put you in touch with experienced fabricators who will work with you and advise you reliably on whether your problem may be solved with metal powders.

PLASTIC METALS

DIVISION OF THE NATIONAL RADIATOR COMPANY
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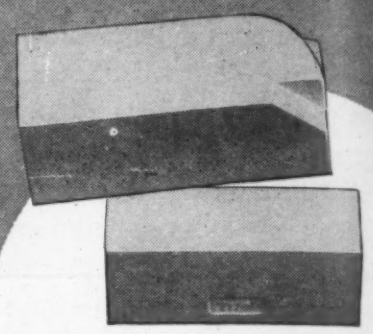
HIGH DENSITY PORCELAIN

• MILL LINING
• SPECIAL SHAPES
• TANK LINING



More Production
Longer Life
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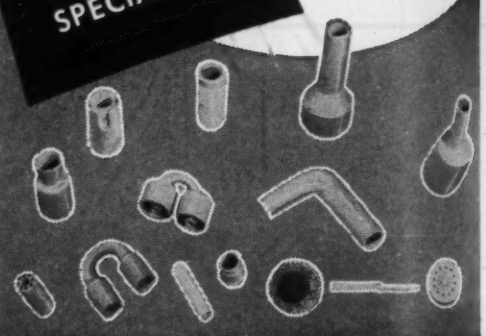
McDanel Super High Density Lining Brick in routine production is giving better than two times longer life over conventional porcelain lining.

That's why—for hard, tough grinding—you should line your grinding mills with McDanel High Density Brick.

This high density brick—for all types of ball mill grinding—comes in a complete range of sizes to fit all types of batch or continuous mills.

Write for "McDanel Industrial Porcelains" catalog.

HIGH TEMPERATURE PORCELAIN SPECIALTIES



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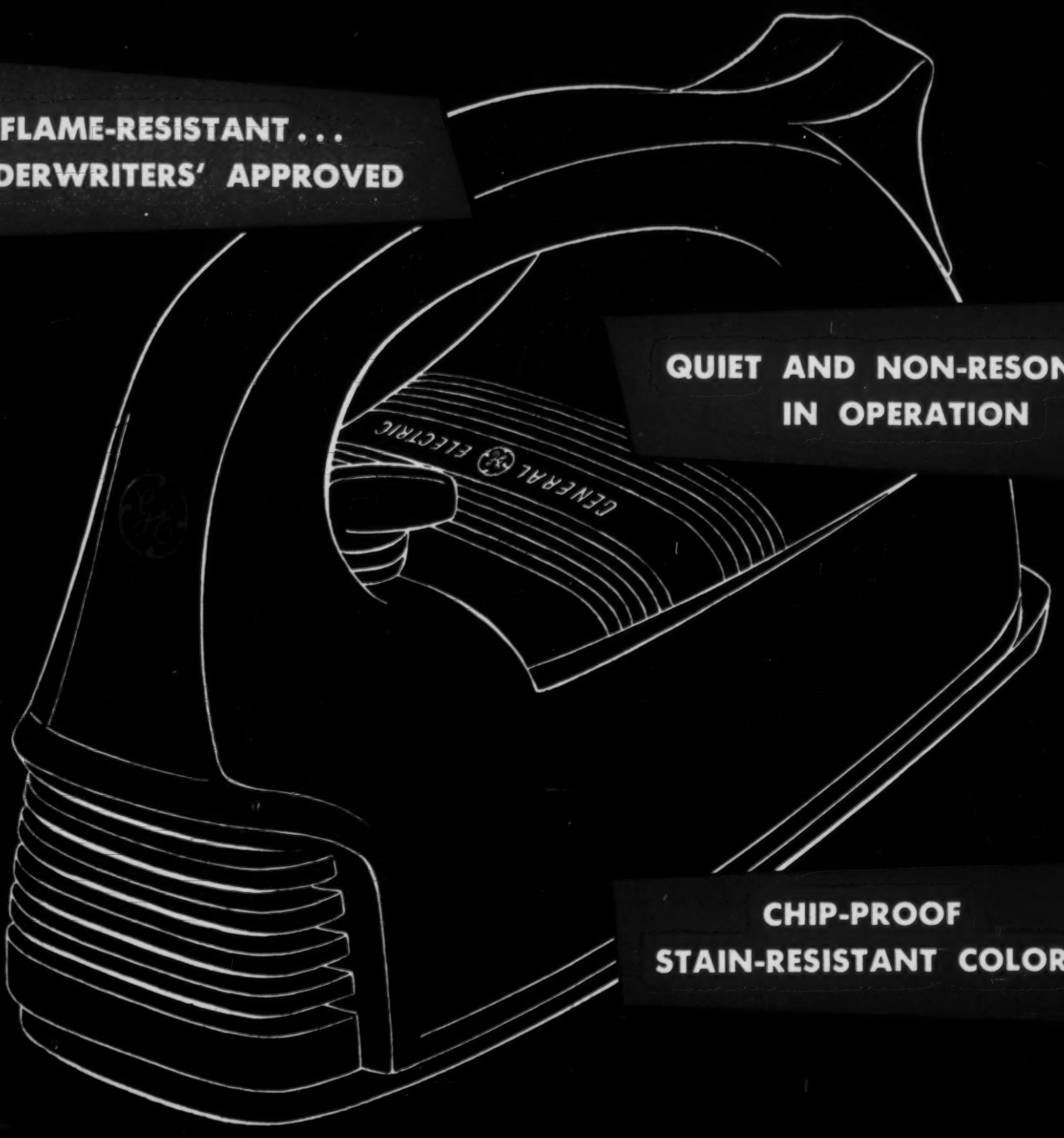

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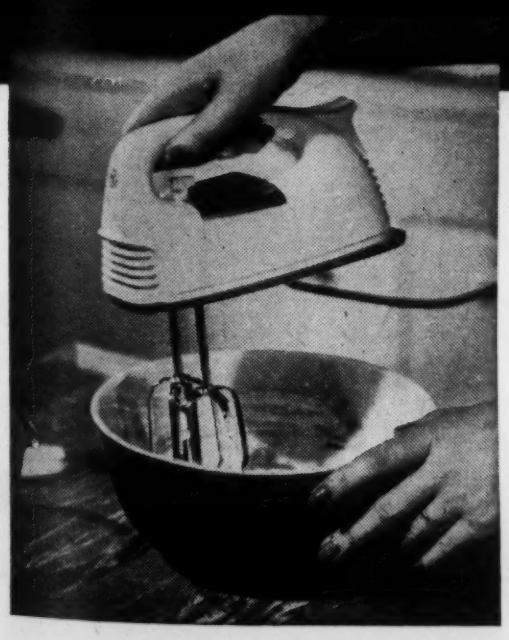

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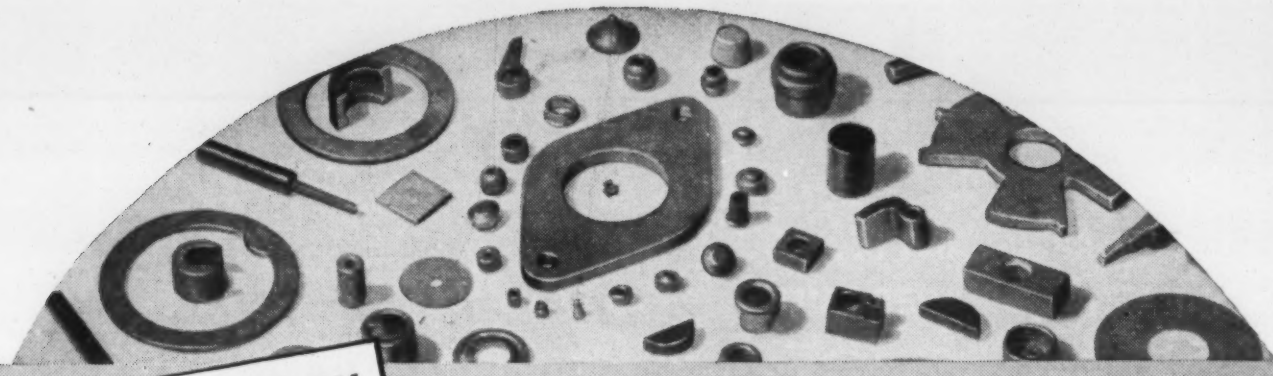

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the modern method of manufacturing

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POWDER METALLURGY is the process being chosen for the manufacture of many products because of the cost savings produced from this automatic, high speed production method. Parts such as porous, self-lubricating bearings, carbon brushes, and insulators, Alnico magnets, carbide tool bits, magnetic radio cores, contact buttons, gears, cams and literally thousands of other items are accurately and automatically made with unbelievable cost savings on Kux Presses.

BUILDERS of the most complete line of machines available for this industry, Kux Presses have been selected by all the leading manufacturers for the superiority in design and construction built into every model. A penny post card will bring you detailed information and an illustrated catalogue.

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Pressure 150 tons
Parts up to 6" diameter
Die fill 6"

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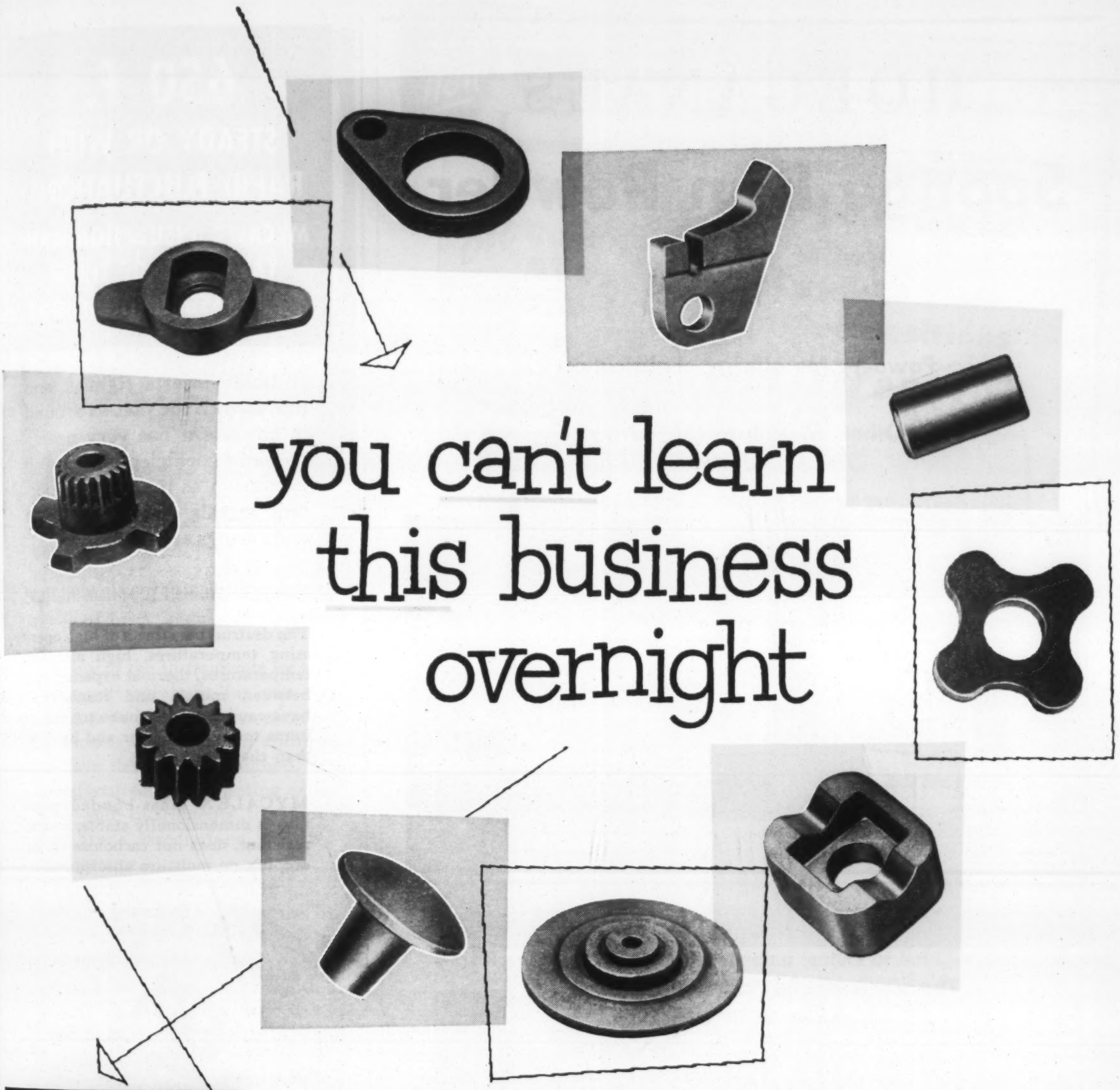
Multiple Motion mechanical operation
Pressure 35 tons
Parts up to 3" diameter
Die fill 2¼"

KUX MACHINE COMPANY
6725 N. RIDGE • CHICAGO 26, ILLINOIS



you can't learn this business overnight

METAL POWDER PARTS BY MORAINE

After more than a quarter-century spent in making metal powder parts—*billions* of them—we feel we have amassed an impressive combination of knowledge and experience. And—more important—we continue to learn! The physical properties of our metal powder parts continue to improve; customers are offered an ever-widening choice of materials; parts are produced for ever-widening applications. Yes, we're proud of our position in the field of powder metallurgy . . . proud of the way in which our products continue to serve by improving performance and lowering costs.

moraine products

DIVISION OF GENERAL MOTORS CORPORATION • DAYTON, OHIO

HOEGANAES

Sponge Iron Powder

for

Powder Metallurgy Fabrication

& Other Metallurgical Purposes

The new American Plant at Riverton, N. J.
will shortly be in production.

•

EKSTRAND & THOLAND, INC.

441 LEXINGTON AVENUE

NEW YORK 17,

N. Y.

We will be at Metal Powder Association meeting in Cleveland, April 21st and 22nd, 1953.

BOOTH NO. 14

650° F.

STEADY OR WITH RAPID FLUCTUATIONS

MYCALEX INSULATION CAN TAKE BOTH OF THOSE TEMPERATURE CONDITIONS

It holds inserts tightly, and moves with the metals around it, because it has very nearly the same coefficient of thermal expansion as the most important metals of which inserts and casings are made.

DESIGNER! UNCHAIN YOUR IMAGINATION!

The destructive effects of high operating temperatures, high ambient temperatures, thermal expansion as between metals and insulations, have caused you to make too many items too much bigger and heavier than they need to be.

MYCALEX glass-bonded mica also is dimensionally stable, corona resistant, does not carbonize under arc, has no moisture absorption.

THERE ARE PLENTY OF OTHER USEFUL FEATURES . . . WRITE for the whole story

SINCE 1919
MYCALEX
THE INSULATOR
®

MYCALEX CORPORATION of AMERICA

World's Largest Manufacturer of Glass-bonded Mica Products

Executive Offices: 30 Rockefeller Plaza, New York 20, N.Y.

GENERAL OFFICES AND PLANT

Testing, Research, and NOW... INSTRUMENT DESIGN and MANUFACTURE

The United States Testing Company, Inc., well known in the field of testing and research, is now becoming recognized as a manufacturer of instruments and special testing apparatus.

Many of the instruments we have developed and built for our own use have been accepted as standard by various industries. In addition, we have developed, designed, and manufactured special testing equipment and instruments for industries, trade associations, and technical groups.

For example: we are now manufacturing the low temperature Impact Tester for vinyl plastic film, required for the new proposed Commercial Standard TS-5165. It is also used in the standard test methods of the Plastic Coatings and Film Association.

This tester has been built in our own instrument shops to our own exacting standards and is designed for long, reliable service and ease of operation. A special release mechanism assures uniformity in use by different technicians. A case is furnished.

We invite inquiries on standard testing equipment and on instruments built on a production or custom basis.

UNITED STATES TESTING COMPANY, INC.

ESTABLISHED 1880

1600 Park Avenue, Hoboken, N. J.

PHILADELPHIA • BOSTON • PROVIDENCE
CHICAGO • NEW YORK • LOS ANGELES
MEMPHIS • DENVER • DALLAS

Member of American Council of Commercial Laboratories

...and now **Metal Hydrides** INCORPORATED

12-24 CONGRESS STREET BEVERLY, MASS.

Chrome-Nickel Alloy Powder — 800 A Sup

Supplemental data on Custom Alloy Powders for Alloy Steel Compositions* ...high tensile strength

*50% Chromium—50% Nickel Alloy powder combined with 1% Graphite and electrolytic iron powder.

Tensile strength psi 121,000

(Sintered 2 hrs. at 1200°C.)

Sintered density	6.97
Elongation % in 1"	2.5
Rockwell Hardness	B-99

Multiple advantages accrue to you through the use of MH Chrome Nickel alloy powders for Alloy Steel compositions in your powder metallurgy molding —

- volume production of intricate parts, having higher tensile strength
- miniaturization of parts with greater strength and less mass
- no scrap or waste, no milling or finishing required

Fine particle size is an outstanding feature of MH Chrome Nickel alloy powders, as indicated on the chart below.

COMPARISON OF EFFECTS OF HEAT TREATMENT ON PROPERTIES OF ELECTROLYTIC IRON POWDER PLUS ALLOYS OF VARIED NICKEL—CHROMIUM CONTENTS

Compacting Pressure — 50 tsi
Sintering Condition — 1100°C for 1 hour at temperature in hydrogen

MATERIAL	Electrolytic Iron + 1% Graphite + 10% Alloy (80% Ni — 20% Cr) TENSILE STRENGTH PSI	ELONGATION % IN 1"	ROCKWELL HARDNESS	SINTERED DENSITY G/CC
Sintered	72200	2.5	R_B83	7.11
Coined	76300	4.6	R_B85	7.18
Coined & Annealed	71000	3.5	R_B84	7.15
Coined & Quenched	76900	1.7	R_C25	7.08
Coined, Quenched & Annealed	99500	0.5	R_C15	7.08
Quenched	75800	2.3	R_C19	7.11
Quenched & Annealed	88650	2.3	R_C16	7.11

Electrolytic Iron + 1% Graphite + 10% Alloy (80% Cr — 20% Ni) TENSILE STRENGTH PSI	ELONGATION % IN 1"	ROCKWELL HARDNESS	SINTERED DENSITY G/CC
66100	2.0	R_B99	6.64
63000	2.0	R_B95	6.65
83000	2.0	R_B95	6.65
84400	2.0	R_B100	6.65
92900	2.0	R_B96	6.65
84000	2.0	R_B97	6.65
77300	2.0	R_B95	6.65

SIZE CHARACTERISTICS

(80% Ni — 20% Cr)	
+100	*2.4%
−100 +200	31.9%
−200 +325	28.5%
−325	37.2%

(80% Cr — 20% Ni)	
−100 +200	4.7
−200 +325	9.7
−325	85.6

(50% Cr — 50% Ni)	
+100 mesh	0.8%
−100 +150	4.5
−150 +200	8.9
−200 +270	11.0
−270 +325	12.2
−325	62.6
Apparent Density g/cc By Scott Volumeter	1.89

For detailed information, write:

METAL HYDRIDES INC.

16 CONGRESS STREET · BEVERLY · MASS.

Producers of

Metal Powders

Copper Powder
(ELECTROLYTIC GRADE)

Atomized Copper Base Alloy Powders

Solder Powder

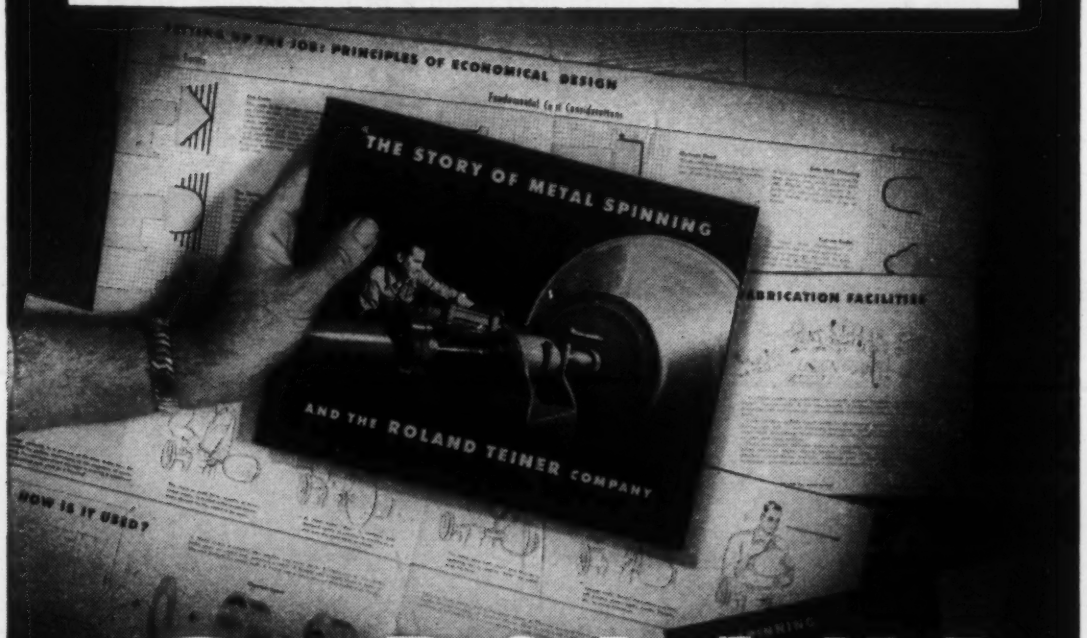
Silver Powder

Tin Powder

•

THE AMERICAN METAL CO., LTD.
61 BROADWAY, NEW YORK 6, N. Y.

WRITE FOR "THE STORY OF METAL SPINNING." Find out how engineers design for lower costs; how to use the Teiner experimental shop and how Teiner provides all-gauge — all-metal — any-quantity spinning for industry. Read about this spinning shop, now largest in the east and tops in scientific experimental spinning. ***Ask for Brochure 52M.***

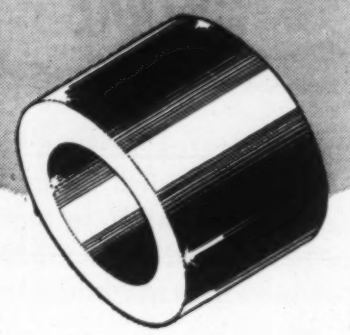


ROLAND TEINER CO INC · METAL SPINNING ·

ROLAND TEINER
COMPANY, INCORPORATED
134 TREMONT ST., EVERETT 49, MASS. Tel. EV 7-7800

GRAPHALLOY
TRADE MARK REG. U. S. PAT. OFF.

OIL-FREE
SELF-LUBRICATING
BUSHINGS



"WORK WHERE OTHERS WON'T"

Widely Used Where Ordinary Oil Lubrication Is Impractical or Impossible.

EXCELLENT DURABILITY • CONSTANT CO-EFFICIENT OF FRICTION • APPLICABLE OVER A WIDE TEMPERATURE RANGE — EVEN WHERE OIL SOLIDIFIES OR CARBONIZES **• OPERATE DRY, OR AT HIGH SPEEDS SUBMERGED IN WATER, GASOLINE AND OTHER LIQUIDS • EXCELLENT FOR CURRENT-CARRYING BEARINGS**

GRAPHALLOY materials are also in wide use for oil-free, self-lubricating piston rings, seal rings, thrust washers, friction discs, pump vanes etc.

OTHER GRAPHALLOY PRODUCTS

BRUSHES

CONTACTS

For applications requiring low electrical noise, low and constant contact drop, high current density and minimum wear. Used for SELSYNS, DYNAMOTORS, SYNCHROS, ROTATING STRAIN GAGE pick-ups and many other applications. Brush Holders and Coin Silver Slip Rings also available.

GRAPHITE METALLIZING CORPORATION
1010 NEPPERHAN AVENUE • YONKERS, NEW YORK

☐ Please send data on Graphalloy Oil-Free BUSHINGS.
☐ Send data on BRUSHES and CONTACTS.

NAME & TITLE
COMPANY
STREET
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Glidden

Resistox Metal Powders

• Introduced just one year ago, Resistox Copper and Lead Powders have proved their oxidation resistance and performance qualities in many fields. Reports indicate that these powders have 5 to 10 times the stability of ordinary powders. Why not test and prove Resistox Metal Powders in your plant?

• You are invited to visit our Booth at the Metal Powder Show and see Resistox Copper Powders and Lead Powders demonstrated, or write to The Glidden Company, Chemicals • Pigments • Metals Division, 1396 Union Commerce Building, Cleveland 14, Ohio.

QUALITY Glidden PRODUCTS

Other Products:

Cuprous Oxide

Cupric Oxide

Cubond *(Copper brazing paste)*

THE GLIDDEN COMPANY • CHEMICALS • PIGMENTS • METALS DIVISION

Baltimore, Md. • Collinsville, Ill. • Oakland, Calif. • Hammond, Ind. • Scranton, Pa.

POSITION WANTED

with a coil that has an important job to do, by a core made of G A & F Carbonyl Iron Powders. Core offers know-how born of long experience, high permeability, high Q, unusual stability and references from many major employers....

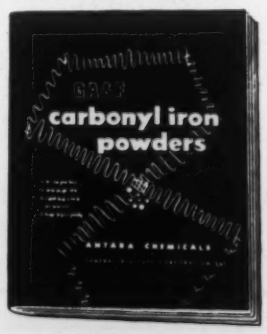
G A & F Carbonyl Iron Powders are used to produce cores for transformer and inductor coils of every form—to increase Q values, to vary coil inductances, to reduce the size of coils, to confine stray fields and to increase transformer coupling factors.

These powders are microscopic, almost perfect spheres of extremely pure iron. They are produced in seven carefully controlled types, ranging in average particle-size from three to twenty microns in diameter.

Similarly, their properties vary, making them useful in many different applications. Engineers have commented on the fact that cores made from these powders lend themselves to smoothness of adjustment and to ease of grinding. The extremely small size of the particles is of enormous value, since eddy currents develop only within each particle—proportional to the square of the particle diameter.

We urge you to ask your core maker, your coil winder, your industrial designer, how G A & F Carbonyl Iron Powders can increase the efficiency and performance of the equipment or product you make, while reducing both the cost and the weight.

Write for wholly new 32 page book—the most comprehensive treatment yet given to the characteristics and applications of G A & F Carbonyl Iron Powders. 80% of the story is told with photomicrographs, diagrams, performance charts and tables. For your copy—without obligation—kindly address Department 47.



G A & F® CARBONYL IRON POWDERS

MEMBER mpa METAL POWDER ASSOCIATION

ANTARA® CHEMICALS

Division of GENERAL DYESTUFF CORPORATION

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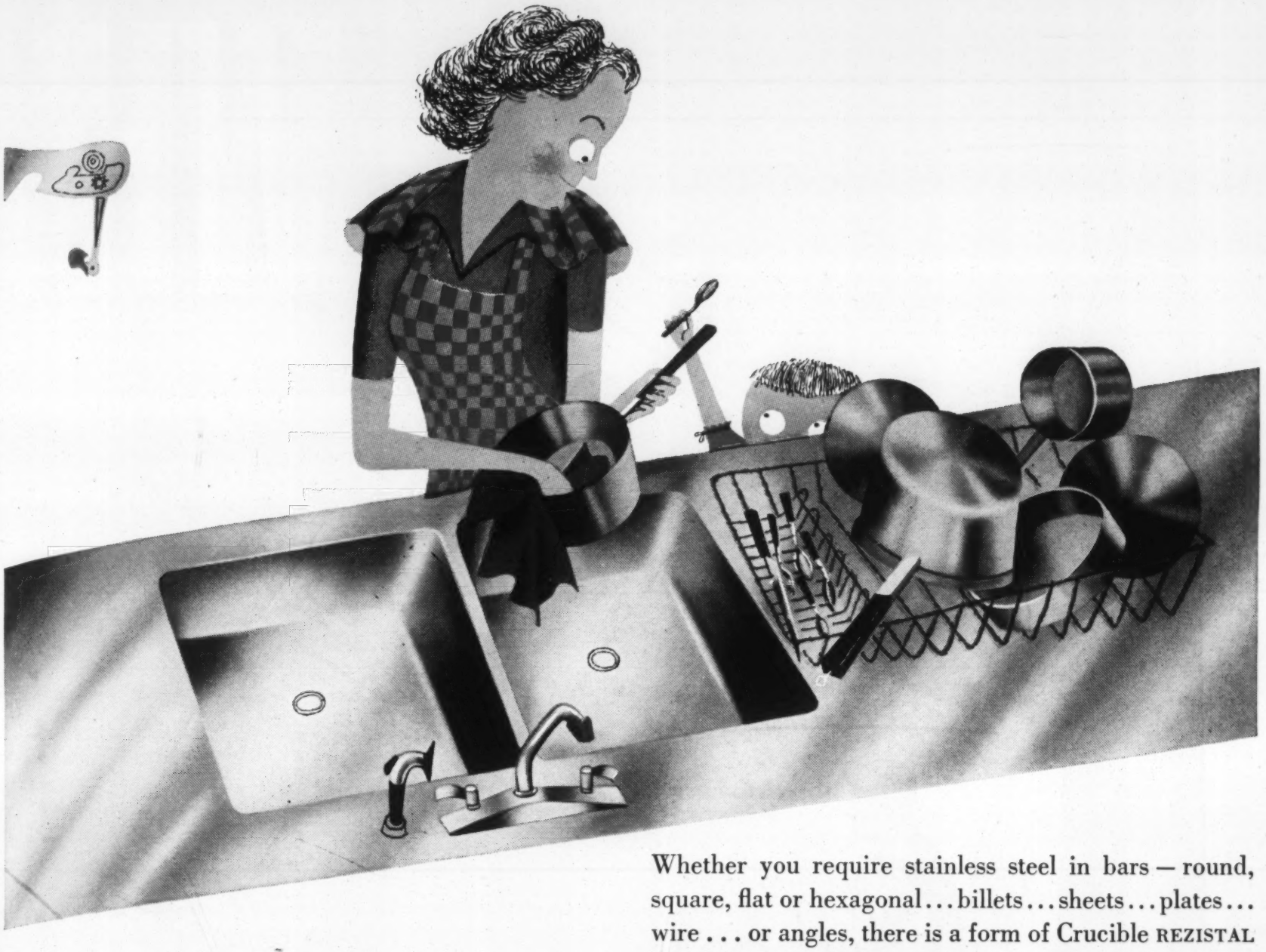
gdc ANTARA



everything in stainless... including the kitchen sink

Whether you require stainless steel in bars — round, square, flat or hexagonal... billets... sheets... plates... wire . . . or angles, there is a form of Crucible REZISTAL stainless that will fill your specific needs. And Crucible REZISTAL stainless steel is available in a wide assortment of grades, gauges and finishes to meet the diversified requirements of all industries.

Crucible's staff of metallurgists and stainless fabricating specialists are well experienced in solving application problems in the chemical, food processing, dairy, textile, laundry, hospital, pulp and paper and a host of other fields — including uses for Crucible REZISTAL in household articles like cutlery, cooking utensils and the proverbial *kitchen sink.*

If you have a specialized application where the unique qualities of stainless will improve your product or your processing operations, don't hesitate to call in a Crucible representative who can give you the benefit of our broad experience. And when you buy stainless, be sure you specify Crucible REZISTAL, the quality brand of heat and corrosion resistant steels.

CRUCIBLE first name in special purpose steels

53 *years of* Fine *steelmaking*

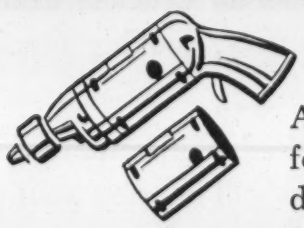
STAINLESS STEEL

CRUCIBLE STEEL COMPANY OF AMERICA, GENERAL SALES OFFICES, OLIVER BUILDING, PITTSBURGH, PA.

STAINLESS • REX HIGH SPEED • TOOL • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

WHY

CASE NO. 69 PORTABLE ELECTRIC DRILL



A switch to aluminum tubing for the housing of this electric drill permitted the manufacturer to capitalize on two important features of aluminum . . . its light weight and its naturally attractive finish.

The savings in weight is a direct selling point since lightness is of utmost importance in a hand tool of this kind. Furthermore, the manufacturer effected important savings in shipping costs.

Production and assembly costs were also cut since aluminum is easily fabricated and requires only simple buffing for finishing.

The manufacturer, Portable Electric Tools, Inc., of Chicago, Illinois, discovered also that aluminum is permanently non-rusting, will neither rust nor corrode should it become nicked or worn.

Perhaps this application of aluminum may suggest to you a similar conversion from other materials. Dollar savings in manufacturing and shipping costs, high corrosion resistance, naturally attractive finish plus added sales appeal are yours with aluminum.

LET ALUMINUM SERVE YOU, TOO

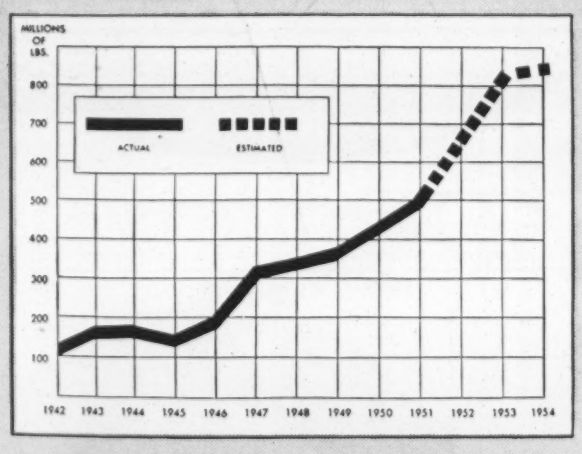
ALUMINUM ?

...because it has an ideal combination of advantages found in no other metal!

More aluminum is being specified in designs today because aluminum improves products and increases sales. Let Reynolds Aluminum Specialists help your designers and engineers get maximum benefits from this modern metal. Remember, only aluminum gives you . . .

- ★ **Lightweight with great strength**
- ★ **Consistently low cost**
  no more now than before World War II
- ★ **Natural resistance to rust and corrosion**
- ★ **Attractive appearance**
- ★ **Ease of fabrication by modern methods**

STILL MORE ALUMINUM COMING



The expanding primary aluminum production of Reynolds Metals Company . . . a historic chapter in the company's 33 years of continuing growth. And primary supplies of aluminum ore will be ample for generations.

To the man in charge of production

Acquaint yourself with accepted techniques for fabricating aluminum. Write on your letterhead for aluminum fabrication books listed at right. On special problems consult with Reynolds staff of aluminum specialists. Reynolds Metals Company, 2560 South Third Street, Louisville 1, Kentucky.

Yours For The Asking . . .
REYNOLDS TECHNICAL BOOKS

(please request on business letterhead)

- Aluminum Data Book
  (Aluminum Alloys and Mill Products)
- Aluminum Structural Design
- Aluminum Powders and Pastes
- Designing with Aluminum Extrusions
- Fastening Methods for Aluminum
- Finishes for Aluminum
- Forming Aluminum
- Heat Treating Aluminum Alloys
- Machining Aluminum Alloys
- Welding Aluminum
- Metals Weight Slide Rule

Complete index of all technical literature and films on aluminum design and fabrication also available.

Be sure to see "Mister Peepers" every Sunday night, 7:30 EST, NBC-TV; hear "Fibber McGee and Molly" every Tuesday night, 9:30 EST & PST, NBC

REYNOLDS ALUMINUM

MODERN DESIGN HAS ALUMINUM IN MIND

specify GRAPHITAR®

(CARBON-GRAPHITE)

proven successful in hundreds of difficult applications

GRAPHITAR bearings, seals, valves, vanes, bushings and other parts like these are helping to cut costs and improve the performance of a great many different products. Here are some important reasons why:

GRAPHITAR is lighter than magnesium yet mechanically strong and durable, with a compressive strength ranging from 4500 to 45,000 psi. It is available in varying degrees of hardness ranging up to that of hardened steel.

GRAPHITAR is practically unaffected by high speeds, high pressures or temperature extremes. Under extreme heat, GRAPHITAR will last much longer than most any other material because it cannot be melted below 6,000° F.

GRAPHITAR is self-lubricating. GRAPHITAR has a lower coefficient of friction than any other material. Even when lubricated with a very light fluid such as water, kerosene or alcohol, it will maintain a liquid film at the bearing surface under relatively high loads.

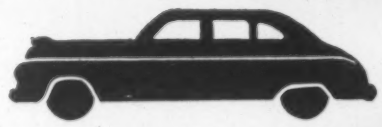
GRAPHITAR is chemically inert and will not corrode even when exposed to concentrated acids like hydrochloric or hydrofluoric.

GRAPHITAR is produced from many different types of carbon and graphite powders. It is available in many different grades and the porosity can be controlled to meet the requirements of specific applications.

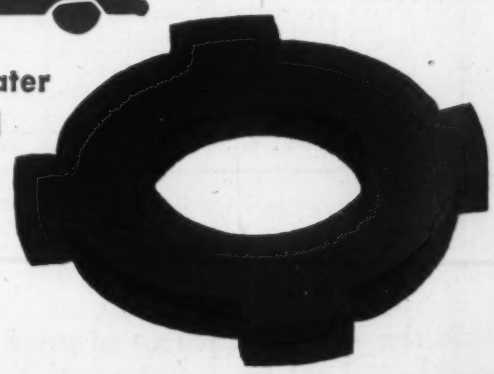
GRAPHITAR can be formed in fairly intricate shapes and ground to tolerances as close as .0005". GRAPHITAR parts can be supplied in virtually unlimited quantities.

outboard motor pump bearing

steam valve rotor



automotive water pump seal



THE UNITED STATES

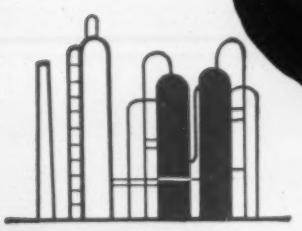
the versatile engineering material that has

gasoline meter valve seat

metal backed
steam joint bearing

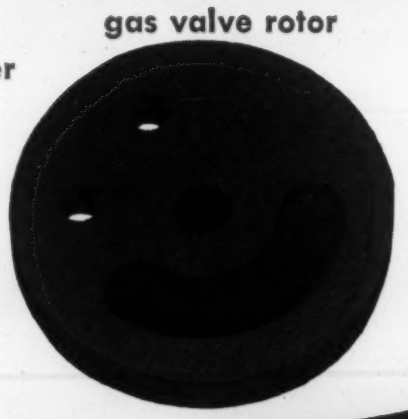
sump pump bearing

aircraft fuel pump seal



chemical meter
piston

gas valve rotor



aircraft accessory seal

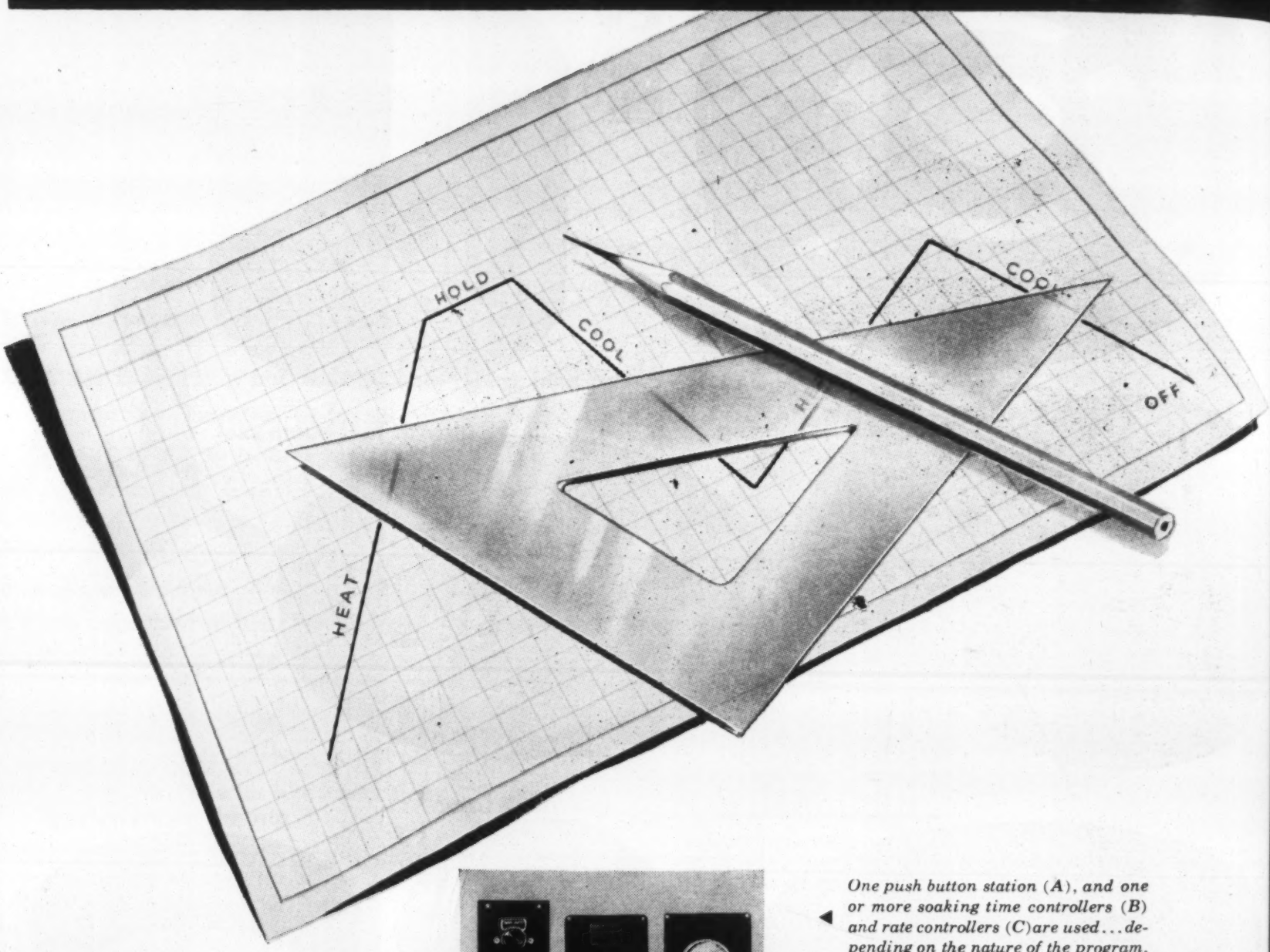
milking machine vane

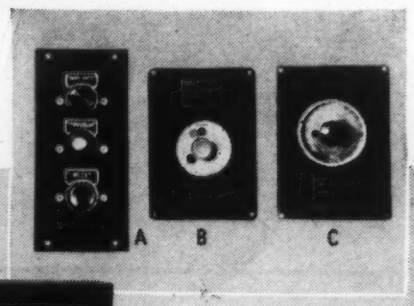
GRAPHITE COMPANY

DIVISION OF THE WICKES CORPORATION, SAGINAW, MICHIGAN

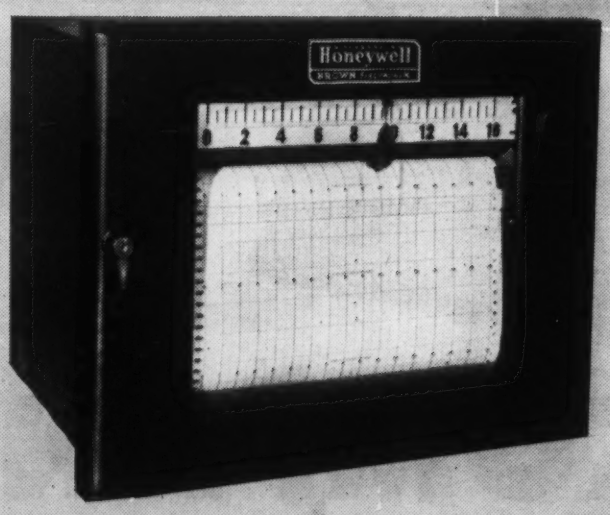
Plan Time *vs*

any way you like . . . with NEW





One push button station (A), and one or more soaking time controllers (B) and rate controllers (C) are used . . . depending on the nature of the program.



BROWN PROGRAM CONTROLLER WITH MOTOR DRIVEN INDEX

. . . the peak in flexibility, providing an infinite variety of programs. Heating or cooling rates are calibrated in degrees/hour, soaking time in hours or minutes . . . both are easily set. Three front-of-instrument temperature settings are available at which heating rate can change or soaking begin. Automatic change from heating to artificial cooling can be provided. Multi-zone control is also available.

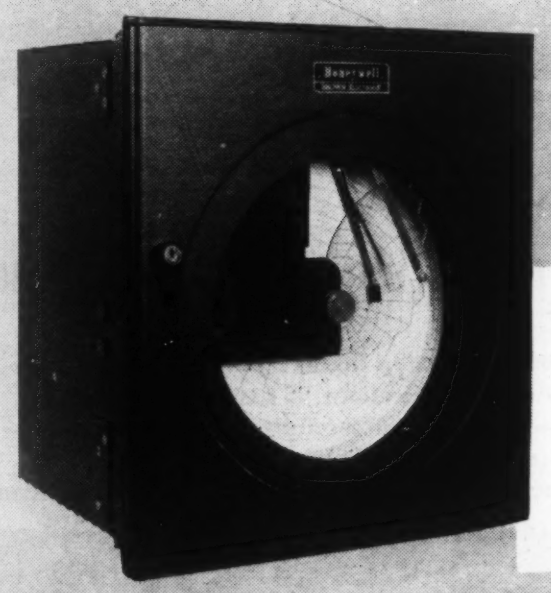
Temperature

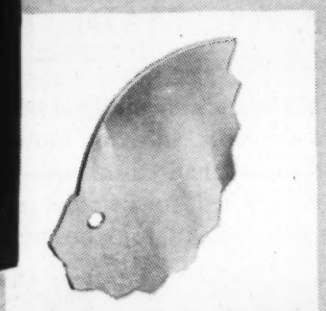
ElectroniK Program Control

Now, *ElectroniK* Program Controllers offer you a free hand in securing automatic regulation of time-temperature cycles. The way these controllers conduct furnaces through complete heating, cooling and soaking periods . . . signalling operators when critical points are reached . . . shutting off equipment at the end of the cycle . . . makes them exceed human abilities.

ElectroniK Program Controllers are designed for complete systems. Available with all varieties of electric and pneumatic control forms (including time or position-proportioning control). For a discussion of how this new, advanced control can improve your production, call in our local engineering representative . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4517 Wayne Ave., Philadelphia 44, Pa.





BROWN CAM-OPERATED PROGRAM CONTROLLER

. . . for frequently repeated cycles. Cam is easily cut to desired time-pattern on calibrated disc of clear plastic. Nonlinear rise or fall is readily produced. Any number of heating, cooling and holding periods can be incorporated. Entire program is readily apparent, and can be duplicated at any time. Program change requires only the replacement of the cam.

Plastic cams are easily cut to any desired pattern.

● **REFERENCE DATA: Write for Bulletin 1501, "*ElectroniK* strip chart program controllers". . . and Bulletin 1502, "*ElectroniK* circular chart program controllers".**

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

First in Controls

H HONEYWELL

HOW MUCH WILL CORROSION

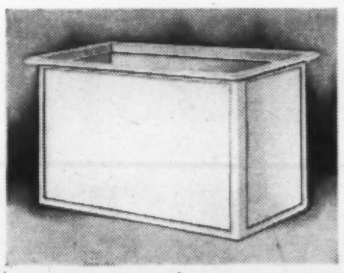
HOW MUCH WILL CORROSION COST YOU THIS YEAR?

CHEMICALS CAN CORRODE METALS IN 12 MONTHS OR LESS.

UNPLASTICIZED P.V.C. JUST DOESN'T CORRODE.

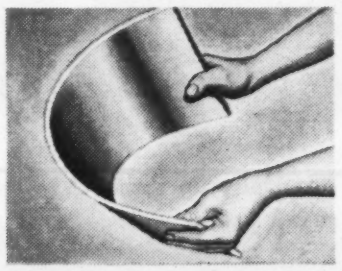
Not a cent...IF YOU SWITCH TO UNPLASTICIZED P.V.C. MADE FROM FIRESTONE EXON 402-A

Unplasticized P.V.C. is a new material of construction that is highly resistant to most corrosive elements. In many industrial applications, it has proven to be superior–less expensive–than customary metals. Check carefully the advantages of Unplasticized P.V.C. Then, for detailed information on how this new material of construction can help you in *your* business, consult Firestone Chemical Sales Division.

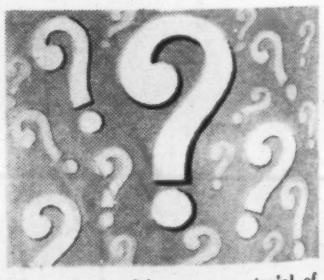


Fume Ducts, Tank Liners, Similar Applications–Unplasticized P.V.C. made from EXON 402-A is ideal for fume ducts and tank liners because it is highly resistant to moisture, acids, oxygen, sunlight, ageing and other corrosive elements.

Industrial Pipe–Naturally, piping extruded from Unplasticized P.V.C. is resistant to all types of corrosion. What's more, it is extremely light weight in comparison to metal...therefore easier and less expensive to handle.



Versatility–Unplasticized P.V.C. made from EXON 402-A can be welded, sawed, sheared, stamped, milled, planed, drilled, embossed, rolled, cemented. It is easily worked on conventional metal and wood working equipment.



How does this new material of construction fit into *your* picture? Have your engineers consult the Firestone Chemical Sales Division on proper applications of Unplasticized P.V.C. made from EXON 402-A...or write:

Firestone ..... EXON ..... *Chemical Sales Division*

☆ FIRESTONE PLASTICS COMPANY
POTTSTOWN, PENNSYLVANIA
A Division of Firestone Tire & Rubber Co.

IMPORTANT: Firestone supplies EXON 402-A only. This resin is used by many of America's leading fabricators of Unplasticized P.V.C. end-products

COST YOUR CUSTOMERS THIS YEAR?

Not a cent... IF YOU SELL THEM

UNPLASTICIZED P.V.C. MADE FROM FIRESTONE EXON 402-A

America's leading manufacturers are becoming more and more *corrosion conscious!* And no wonder. Every year, corrosion costs industry millions of dollars.

That's why Firestone has scheduled an entire series of full-page advertisements to appear in *Business Week* and *U. S. News and World Report.* (The first advertisement in this series is illustrated on the opposite page.)

These advertisements were designed with one thought in mind: to suggest Unplasticized P.V.C. to businessmen as a possible solution to their corrosion problems. In doing this, the series will stimulate an increased demand for this new material of construction. Have *you* considered ways in which you can adapt this new material of construction to products you now make or could make with your present production facilities?

Unplasticized P.V.C. that is made from Firestone EXON 402-A is highly-resistant to moisture, acids, oxygen, sunlight, aging and other corrosive elements. It is extremely lightweight in comparison to metal ...and therefore easier and less expensive to work with.

What's more, Unplasticized P.V.C. made from Firestone EXON 402-A can be welded, sawed, sheared, stamped, milled, planed, drilled, embossed, rolled, punched, cemented. It is easily worked on conventional metal- and wood-working equipment.

☆ ☆ ☆

Firestone has the experience and technical background to help you meet the increased demand for Unplasticized P.V.C. For detailed information on applications...and for advice and consultation on new uses you may discover ...call or write:

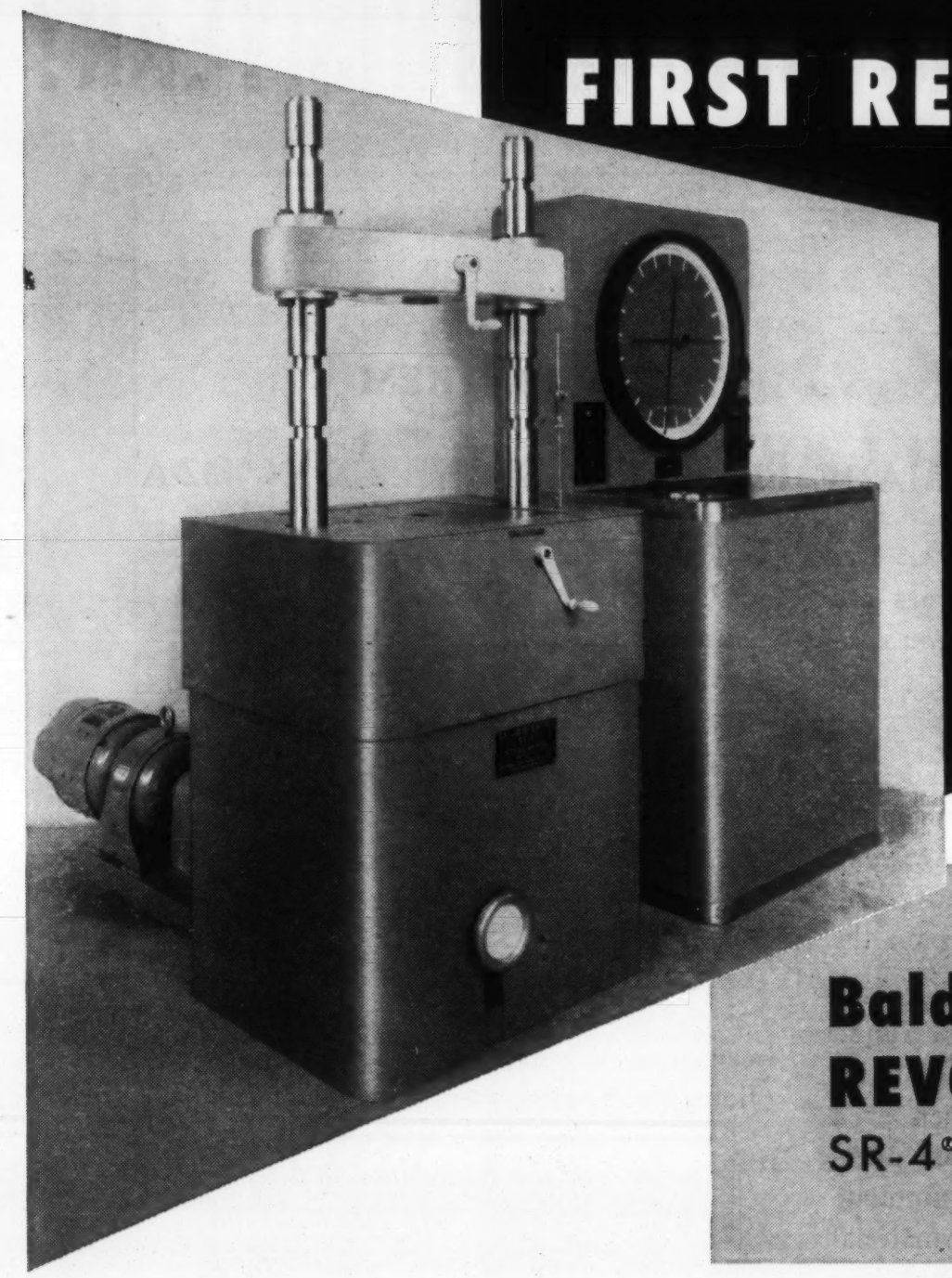
Chemical Sales Division

DEPARTMENT 11D

FIRESTONE PLASTICS COMPANY

POTTSTOWN, PA.

A Division of Firestone Tire & Rubber Co.



FIRST REAL ADVANCE

in materials testing equipment

IN 20 YEARS

Baldwin-Emery's REVOLUTIONARY

SR-4® testing machine

At Testing Headquarters, after five years of development, Baldwin-Emery's new SR-4 FGT Testing Machine is now being produced in quantity. The most versatile of all universal testing machines, incorporating an electric weighing system and electronically-controlled loading mechanism, it is the first really basic change in materials testing equipment in the past twenty years.

With a 50,000 lb. load capacity, this SR-4 FGT Testing Machine has these characteristics which contribute to its remarkable performance: a single reversing screw drive . . . a single convenient specimen location for both tension and compression tests . . . automatic cycling of load . . . high speed response to dynamic as well as static loads . . . extreme structural rigidity . . . ability to feed back output from the load cells and SR-4 extensometer for control purposes . . . ability to record load vs. strain statically with the Baldwin-Peters SR-4 recorder as well as dynamically with oscillographs or oscilloscopes.

IT IS THESE CAPABILITIES WHICH MAKE THIS MACHINE SO VERY VERSATILE:

1. Static tension, compression, flexure and torsion tests.
2. Top center zero for complete reverse load cycle.
3. Alternating load cycling for fatigue testing between fixed load points or fixed deflection points.
4. Shock tests on structures.
5. Creep, stress rupture, and relaxation tests.
6. As a straining frame for experimental stress analysis using Stresscoat, strain gages and photoelasticity.

To learn more about this new testing machine, please write for Bulletin 4202 to:
Dept. 2223, Baldwin-Lima-Hamilton Corp., Philadelphia 42, Pa.

TESTING HEADQUARTERS

BALDWIN · BLH · LIMA-HAMILTON

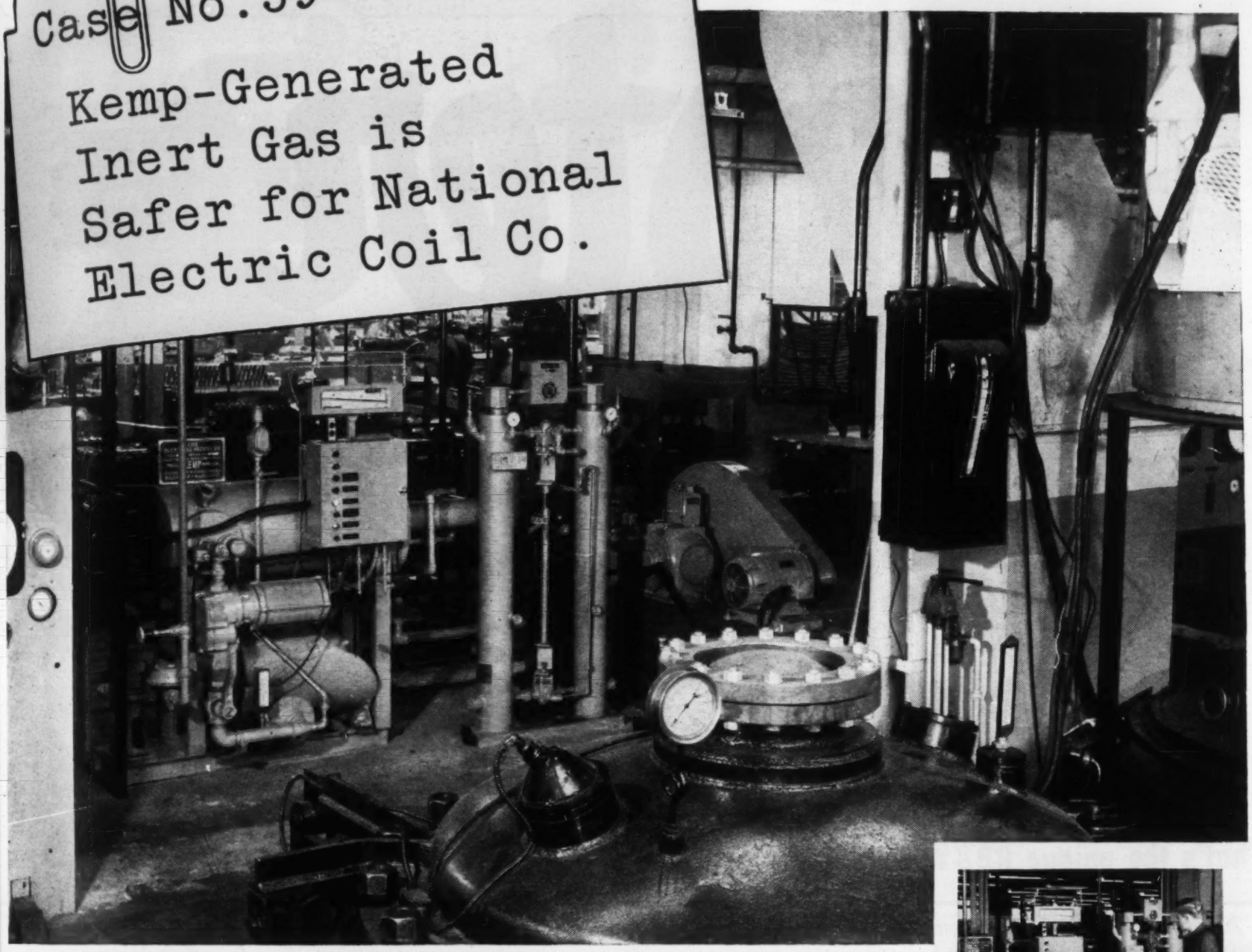
BALDWIN-LIMA-HAMILTON

General Offices: Philadelphia 42, Pa. • Offices in Principal Cities

In Canada: Peacock Bros., Ltd., Montreal, Quebec

Case No. 59

Kemp-Generated Inert Gas is Safer for National Electric Coil Co.



How National eliminates danger of explosion . . . cheaply and conveniently

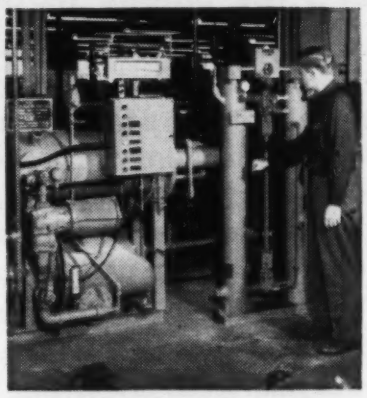
National Electric Coil Co., Columbus, Ohio, impregnates electric coils and windings by forcing in a hot sealing compound with inert gas under pressure. Formerly, the Company used air under pressure, but this created an explosion hazard. National then switched to CO_2 generated by melting dry ice. Although this decreased the danger factor, it was an extremely expensive operation and very inconvenient. To modernize this process and cut costs, National installed a Kemp Gas Generator, Model MIHE.

Kemp Solved the Problem—and More

Now National's Kemp installation delivers a completely satisfactory inert—eliminating any danger of explosion. And it delivers it at a *much lower cost* than the former generating method. In addition, Kemp supplies the gas at the rate required, plus a reserve for storage. As for convenience, the company considers their unit entirely automatic—it is practically never touched. According to Mr. D. E. Stafford, Chief Engineer, "It just sits there and operates."

Kemp Can Solve Your Problem Too

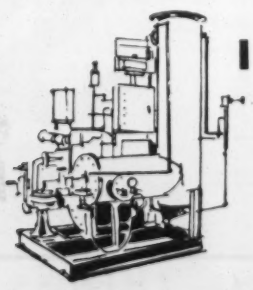
Every Kemp Generator is engineered for fast-starting, easy operation that saves both *time* and *money*. Kemp equipment delivers a chemically clean inert at a specific analysis . . . without fluctuations regardless of demand. And every Kemp design includes the latest firechecks and safety devices. For convenience, safety, and cleaner, more dependable gas—specify Kemp.



Mr. Wm. C. Graessle, of the engineering department, checking the operation. Generator features the Kemp Carburetor, part of all Kemp equipment, to deliver complete combustion . . . without waste, without tinkering.

For more complete facts and technical information, write for Bulletin I-10 to: **C. M. KEMP MFG. CO., 405 East Oliver Street, Baltimore 2, Md.**

KEMP OF BALTIMORE



INERT GAS GENERATORS

CARBURETORS • BURNERS • FIRE CHECKS
METAL MELTING UNITS • ADSORPTIVE DRYERS • SINGEING EQUIPMENT

Faster Stronger and Surer!

That's the unique RB&W SPIN-LOCK Screw

Assembly is faster . . . no washers are needed, and SPIN-LOCK drives easily, even in hard-to-reach spots. No special handling is necessary; screws can be hopper fed. Purchasing takes less time . . . for there's just one requisition to fill. Inventory-taking is faster . . . for there's just one part to stock.

You save all this time because RB&W's new SPIN-LOCK Screw is complete in *one piece* . . . with *exclusive* ratchet-like teeth under the head that lock into the surface, hold tighter than conventional fasteners under vibration.

SPIN-LOCK gives stronger and surer assemblies . . . its heat-treated strength enables it to exert greater clamping force . . . teeth on outer edge of head give additional locking action. Hex, pan, truss, flat heads.

Write to Russell, Burdsall & Ward Bolt and Nut Company, Port Chester, N.Y., for SPIN-LOCK Screw folder containing complete data and specifications.

RB&W—The Complete Quality Line. *Plants at:* Port Chester, N.Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Pittsburgh, Detroit, Chicago, Dallas, San Francisco. *Sales agents:* Portland, Seattle. Distributors from coast to coast.

B.3.1

RB&W

Spin-lock

U.S. Pat. No. 2,253,241

The Tighter, Stronger, Surer Fastener!

108 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

tool steel is our special pride!

Just as mother was known for a special dish, so Crucible stands for the finest in tool steel. For a half-century we have enjoyed this reputation. Naturally, we are proud of it.

We are keeping our research and development in step with industry's everchanging needs for tool steel. We are offering you the benefits of our metallurgical service to solve unusual problems. And we are maintaining full stocks in conveniently-located warehouses so you can get prompt delivery of tool steel.

SEND TODAY for the unique Crucible Tool Steel Selector—a twist of the dial gives the tool steel for your application.

Rex® High Speed Steels
Peerless Hot Work Steels
Halcomb 218
Chro-Mow®
Sanderson Carbon Tool Steels
Ketos®
Airkool Die Steel
Airdi® 150
Nu-Die V Die Casting Steel
CSM 2 Mold Steel
La Belle® Silicon #2
Atha Pneu

SPECIFY YOUR TOOL STEELS BY THESE BRAND NAMES

Crucible Steel Company of America
Dept. MM, Chrysler Building, New York 17, N. Y.
Name_____
Company_____ Title_____
Address_____ City_____ State____

9" diameter, 3-colors

CRUCIBLE first name in special purpose steels

53 years of Fine steelmaking

TOOL STEELS

CRUCIBLE STEEL COMPANY OF AMERICA · TOOL STEEL SALES · SYRACUSE, N. Y.

Have you investigated

"BORON STEELS"

as a ready means to increased hardenability?

Farm equipment and earth-moving machinery manufacturers are using boron steels for axles, spindles, drive gears and many other heavy section parts.

Boron steels—used for pinions, shafts and heavy-duty gears for air-cooled engines—are helping to meet new requirements in the aircraft industry.

In gears, pinions, axles, springs and many other automotive parts, older grades of alloy steels are now being replaced by boron steels.

Boron steels are enabling manufacturers of hand tools and shop equipment to make significant cuts in their annealing costs.

Millions of tons of boron steels made with Vancoram GRAINAL Alloys are now in service.

These steels are doing many of the jobs formerly done only by the older grades of higher alloy steels. They contain, however, far smaller amounts of critical alloying elements—because GRAINAL Alloys replace these elements with respect to hardenability.

If you are having trouble getting steels with the hardenability you require, investigate boron steels today.

Ask your steel supplier for complete information.

VANADIUM CORPORATION OF AMERICA

420 Lexington Avenue, New York 17, N. Y.

DETROIT • CHICAGO • CLEVELAND • PITTSBURGH

VANCORAM BRAND

Producers of alloys, metals and chemicals

Here's why The A. O. Smith Corp.

uses *Summerill*

STEEL PRESSURE TUBING

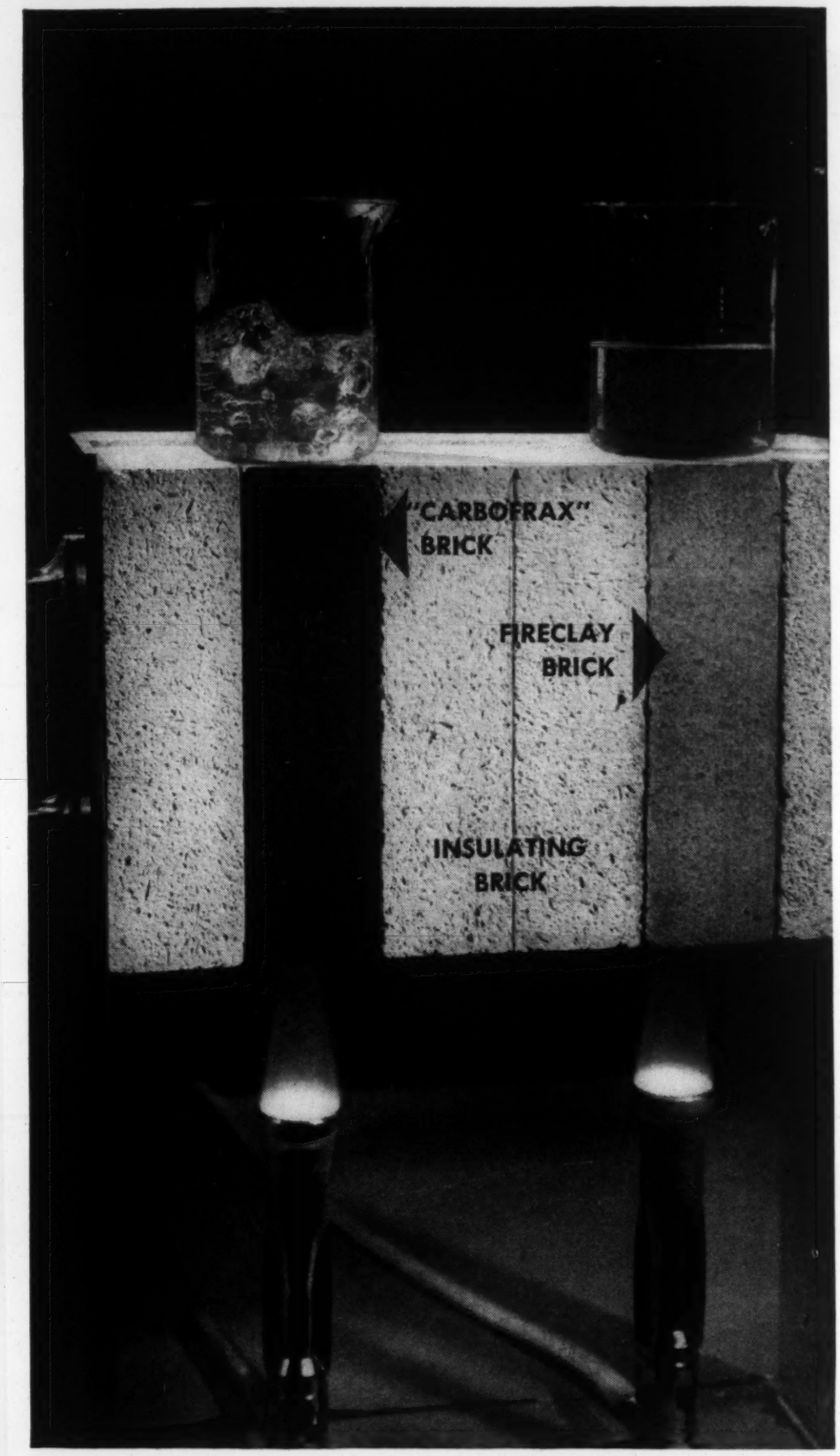
The A. O. Smith Corporation has found that Summerill Steel Pressure Tubing consistently meets their high quality tubing standards. For Summerill Seamless Tubing withstands internal pressures that would cause other tubing materials to quickly fail. It flares easily, and takes sharp bends in stride without flattening or developing an "orange peel" effect on the bend.

Summerill Pressure Tubing is Quality-Controlled from raw materials to finished product in one of the nation's most modern tubing plants. Only prime raw materials are used. As a result, you can depend on Summerill for top uniform quality of product—regardless of whether you buy a single length or by the carload. *And remember this:* Not one Summerill customer has ever received a "leaker", or reported a pressure tubing failure! Summerill Pressure Tubing is available in lengths up to 38 feet. ● For further details or technical assistance, call or write: *Summerill Tubing Company Division, Columbia Steel & Shafting Company, Pittsburgh 30, Penna.*

W&D 4600

IN COLD DRAWN SEAMLESS STEEL TUBING

SPECIFY *Summerill* AND BE *SURE!*



Two Meeker burners, two bricks — but see the difference! The beaker on the CARBOFRAX brick boils furiously (through *the length* of a 9" brick). The water on the fireclay brick is barely tepid.

Could you use a

Refractory that transmits heat

. . . as rapidly as chrome-nickel steels?

Here's a refractory that, in certain respects, is more akin to heat-resisting metals than to refractories. CABOFRAX silicon carbide refractory (same basic material as CARBORUNDUM brand abrasive) is, in many ways, one of the most indestructible of materials. At 2460 F., it has a crushing strength of over 10,000 psi. It is inherently resistant to even the most severe abrasion—often outlasting alloy parts, 5 or 10 to 1. And it can be used at temperatures up to and exceeding 3000 F.... roughly 1000 degrees over the upper limits for metals!

But, most important, at elevated temperatures these refractories conduct heat approximately as fast as chrome-nickel steels. This is 11 to 12 times faster than fireclay refractories!

Thus CARBOFRAX refractories are ideal for radiant tubes, muffles, hearths, and other equipment using *indirect heating*. Since they absorb and release up to five times as many BTU's per second as fireclay, they are also perfect for *heat exchange* equipment, such as checkers or recuperator tubes. Conversely, these refractories play an important role where heat must be *dissipated* (e.g. arc shields, pot linings, etc.).

Do any of these applications suggest possibilities? If so, please write or phone us. And be sure to get our easy-to-read 20-page booklet. It describes the many unusual properties of our Super Refractories line. No obligation, of course.

Dept. R-43, Refractories Division

The Carborundum Company, Perth Amboy, N. J.

Send complimentary copy of Super Refractories booklet to:

NAME_____

POSITION_____

COMPANY_____

STREET_____

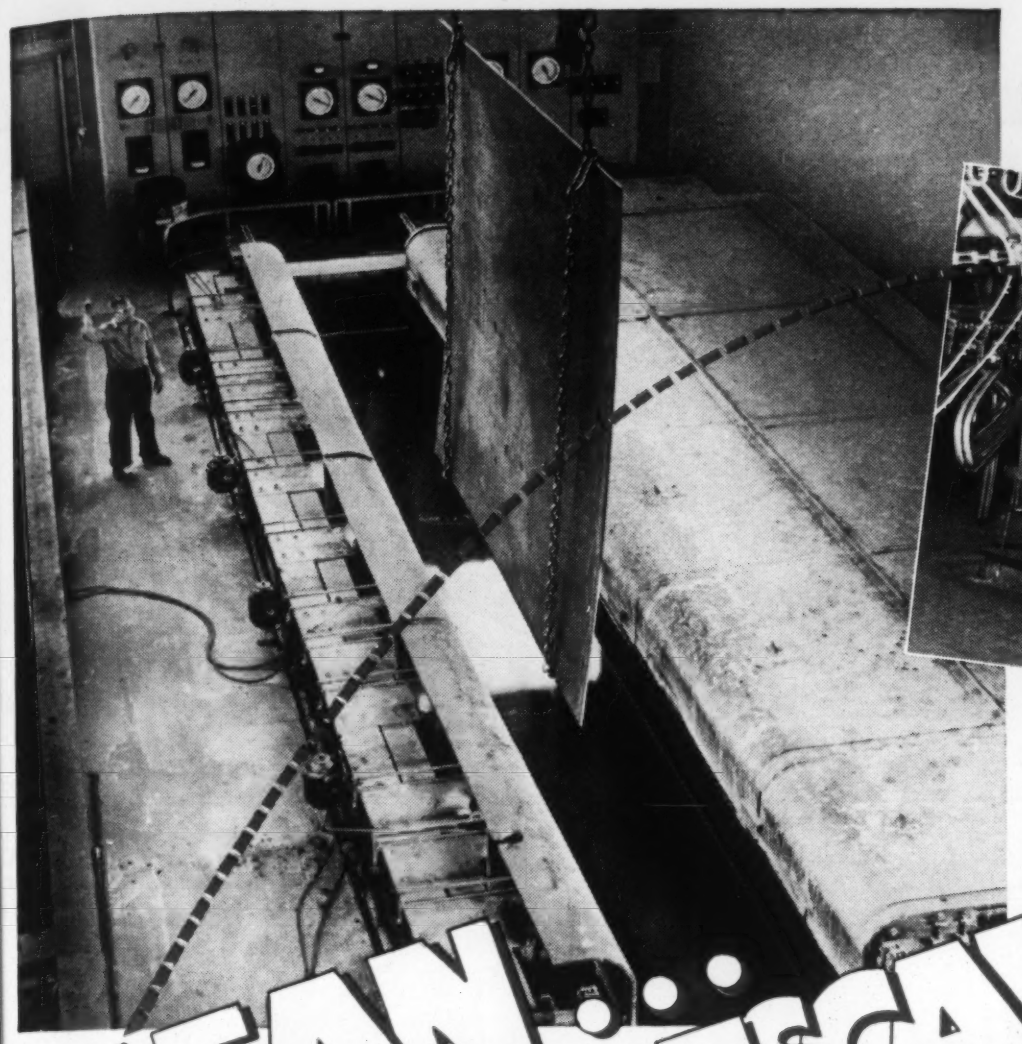
CITY_____ ZONE____ STATE_____

Super Refractories by

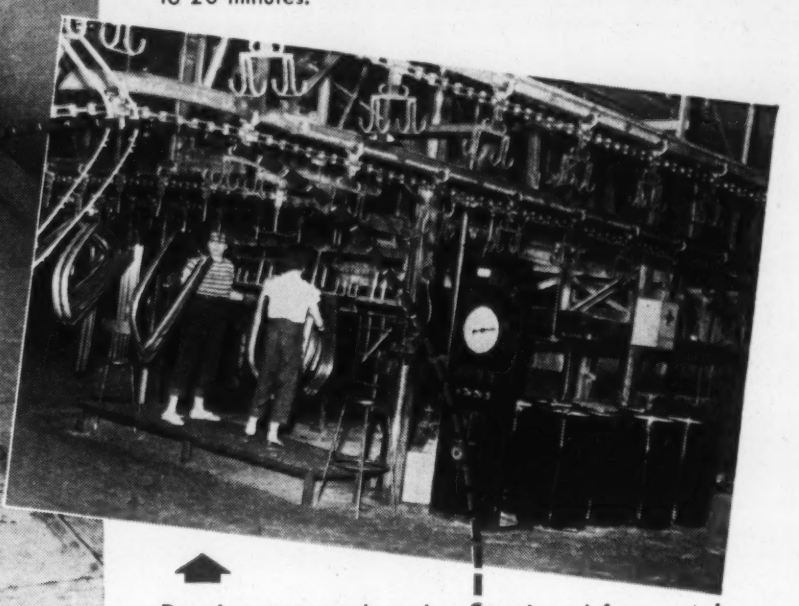
CARBORUNDUM

Trade Mark

"CARBORUNDUM" AND "CARBOFRAX" ARE REGISTERED TRADEMARKS OF THE CARBORUNDUM CO.—WORLD'S LARGEST MANUFACTURER OF SUPER REFRACTORIES



Stainless, carbon, alloy and high-speed tool steels and non-ferrous alloys descaled in from 15 seconds to 20 minutes.



Drawing compounds and paint stripped from metal stampings in 50 seconds.

CLEAN... DESCALE... DESAND

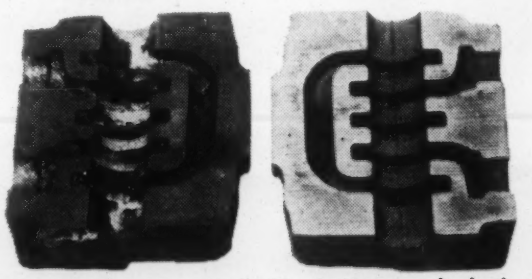
...faster, better at appreciably less cost

From removing metallic oxide scale from huge plates, coils or bars to desanding molds or cleaning residual materials from stampings, the Ajax Electric Salt Bath Furnace paves the way to appreciable savings in labor, floor space and time. What's more, the work is done far more efficiently than is possible with sandblasting, acid pickling, electrolytic anodic cleaning or other methods.

The Ajax Salt Bath Furnace is adaptable to many metal and alloy types. Different metals and different metal shapes can be descaled simultaneously. The bath acts uniformly on all parts of the work including blind holes. The process reacts only on scale, sand or residual materials. The base metal is not affected and there is no hydrogen embrittlement. First cost of the equipment is low and so is upkeep. Pot and electrode life is measured in years and the bath can be regenerated indefinitely by the addition of low cost chemicals. Where desired, the entire process can be mechanized for highly efficient mass production.

Write today, giving details of your finishing problem. Let Ajax engineers prove these claims—at not the slightest obligation. Reprinted technical articles on cleaning, descaling and desanding are available on request.

Grease, drawing compounds, residual rubber, carbon black, plastics, paint and enamel removed in minutes with less labor.



Residual sand removed from these pump casings by 3-minute salt bath immersion at 700° F.

AJAX ELECTRIC COMPANY, INC.

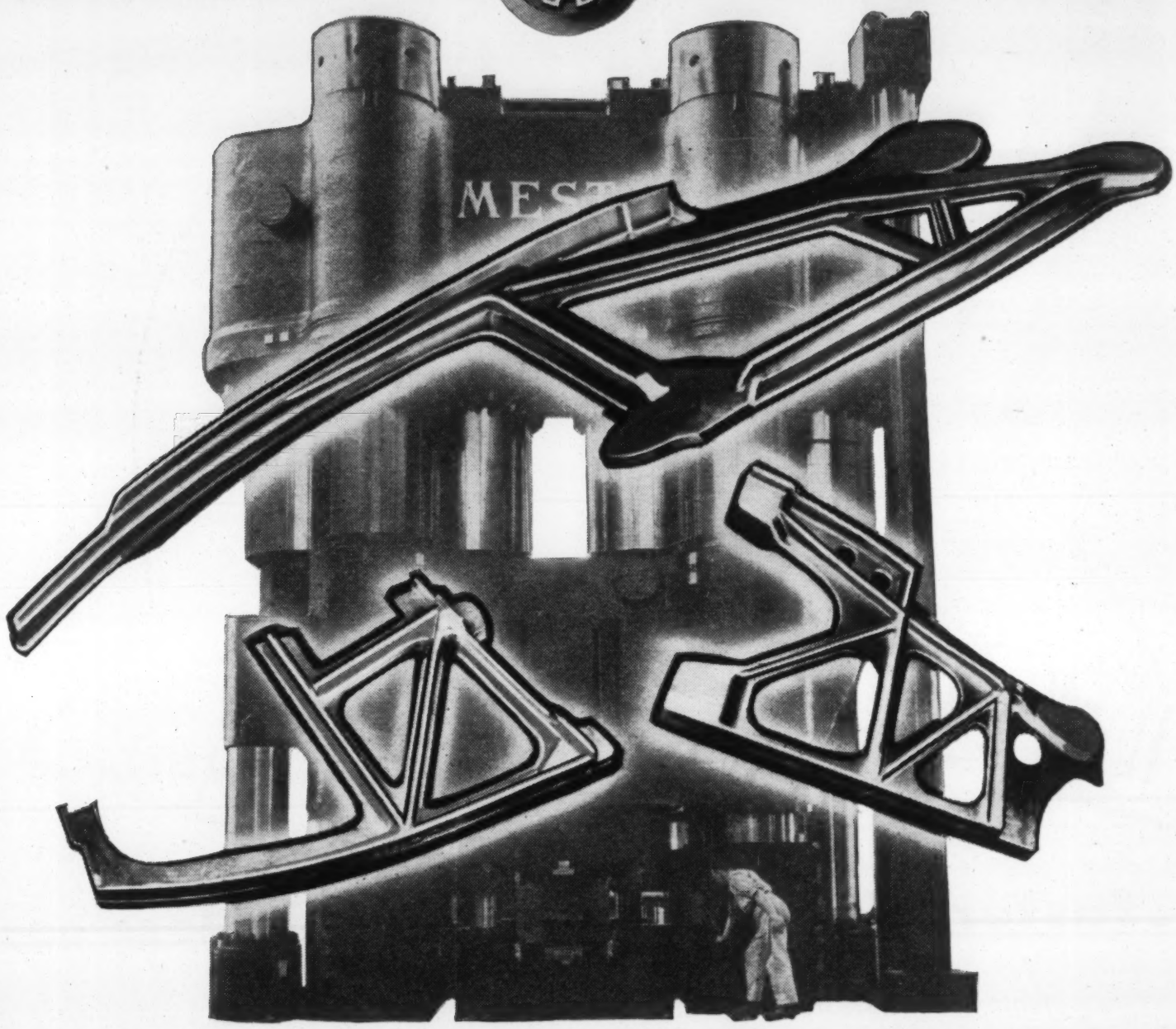
WORLD'S LARGEST MANUFACTURER OF ELECTRIC HEAT TREATING FURNACES EXCLUSIVELY

906 Frankford Avenue. Philadelphia 23, Pa.

Associate companies: Ajax Electric Furnace Corp.; Ajax Engineering Corp.; Ajax Electrothermic Corp.

SELF-REGULATING • SELF-CIRCULATING

AJAX ELECTRIC SALT BATH FURNACES



Greater Size and Speed in Aircraft have created engineering problems, the solution of which has required larger and larger forgings of high-strength aluminum alloy. *Examples* shown above are forged structural members used in a modern military bomber, the largest more than seven feet over all. These are forged on an 18,000-ton press, the biggest ever built in this country.

Wyman-Gordon Experience—the most extensive in the industry—is keeping abreast of new forging demands involving the use of Steel, Aluminum, Magnesium, High Density Alloys and Titanium.

• • •

Standard of the Industry for More than Sixty-five Years

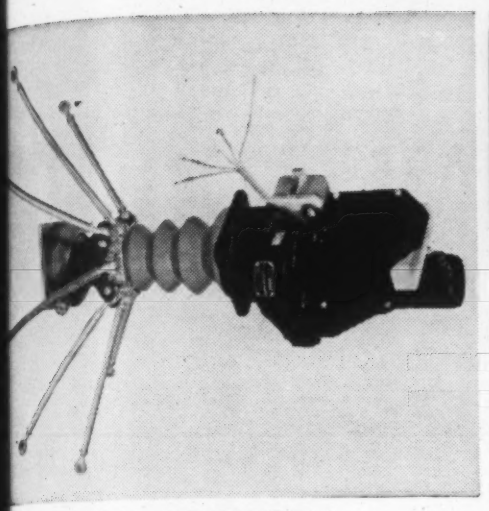
WYMAN-GORDON

FORGINGS OF ALUMINUM • MAGNESIUM • STEEL

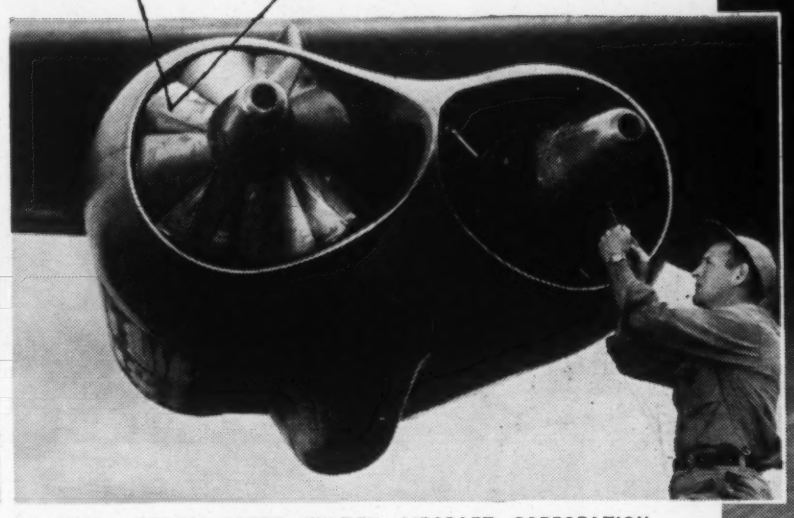
WORCESTER, MASSACHUSETTS

HARVEY, ILLINOIS DETROIT, MICHIGAN

To assure instant operation of jet assist engine air intake doors under icing conditions



COURTESY LEAR INCORPORATED



COURTESY CONSOLIDATED VULTEE AIRCRAFT CORPORATION

SILASTIC* works

where other materials fail!

Auxiliary jet engines are fitted with aluminum air intake doors which close to reduce drag when not in use, and open when the engines are summoned for extra bursts of power at take off or in flight.

These doors must always respond to the pilot's instant command on the ground, at sub-zero altitudes or under icing conditions.

This requirement was met by embedding heating elements in a piece of Silastic sandwiched between two sheets of aluminum that are shaped to form the door segments. The Silastic insulates the heating element; withstands surface temperatures up to 450°F, and conducts heat rapidly to the aluminum intake doors.

These doors are opened and closed by means of an actuator and screw jack assembly. To prevent dirt and ice from fouling the screw jack, exposed sections are encased in a heat resistant Silastic bellows that retains its flexibility at temperatures down to —100°F.

In designing this anti-icing assembly, Silastic proved to be the only material that remained resilient and serviceable after continuous vibration and repeated exposure to temperatures ranging from —100°F to +450°F.

Such performance is typical of Silastic, the Dow Corning silicone rubber. When you need a material that will remain rubbery and retain its excellent dielectric properties after long exposure to temperatures from below —70° to above 500°F, or after prolonged weathering or contact with a variety of hot oils and chemicals, ***specify Silastic.***

*T. M. REG. U. S. PAT. OFF.

Get the facts about Silastic from your fabricator or write direct

first in silicones

DOW CORNING CORPORATION

MIDLAND, MICHIGAN

Atlanta Chicago Cleveland Dallas New York Los Angeles Washington, D. C.
In Canada: Fiberglas Canada Ltd., Toronto England: Midland Silicones Ltd., London

mail coupon today

DOW CORNING CORPORATION, Dept. AF-4, Midland, Mich

Please send me:

☐ List of Silastic Fabricators ☐ Silastic Facts 10a ☐ "What's A Silicone?"

Name _____ Title _____

Company _____

Address _____

City _____ Zone _____ State _____

Here's the new..

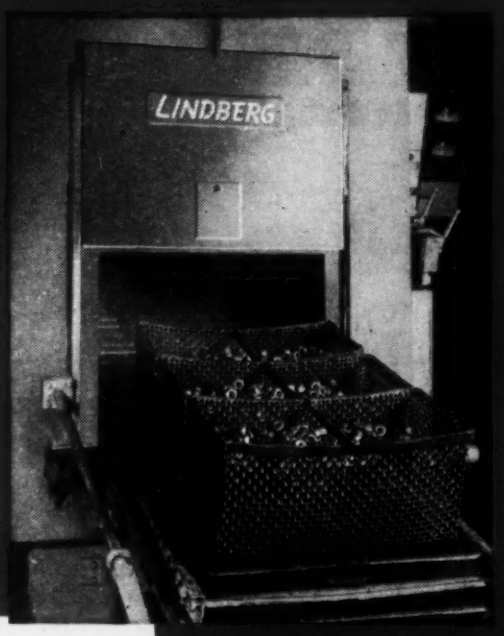
LINDBERG CARBONITRIDING FURNACE

It's many-furnaces-in-one! • It's de-
signed not only for carbonitriding .. bu
also for hardening, carburizing, anneal-
ing and carbon restoration! • It's a self-
contained unit! • It's easy to maintain

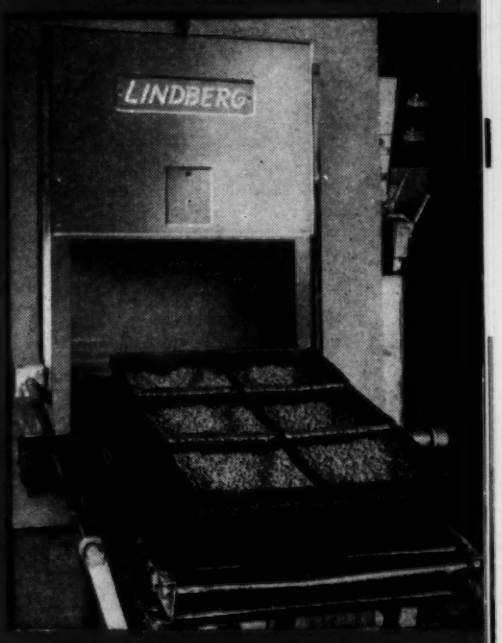
Changing tubes like the blades in your mower! It's easy to change the new Lindberg tubes—just lift one out and hang new ones in place . . . all in a matter of minutes.

The greatest advance in industrial furnace design and construction since Lindberg introduced the Cyclone forced convection tempering furnace back in 1935!

A 320 lb. load of CRS sleeves. Carbonitrided .010 to .015". 90 minutes in heating chamber. Temperature, 1600° F.



A 400 lb. load of CRS hex nuts. Carbonitrided .001 to .005". 60 minutes in heating chamber. Temperature, 1600° F.



A 120 lb. load of CRS screws. Carbonitrided .005 to .008". 45 minutes total time...temperature, 1550° F.

, you must see the new Lindberg bonitriding Furnace. It's many fur- es in one . . . it's easy to maintain . . . a self-contained unit.

heck these important construction ures . . . features that will improve duction quality and volume, and ce production costs.

y furnaces in one . . . Furnace osphere is provided by the Lindberg en" endothermic atmosphere gen- or that is easily adjustable to supply erent atmospheres not only for car- triding, but also for carburizing, on restoration, bright hardening or ealing and normalizing. For anneal- and normalizing the heated charge s in the same chamber used for ing.

y to maintain . . . Instead of old , heavy, unwieldly, horizontal radi- ubes . . . new gas-fired, lightweight s (only 29 pounds) are used. They're le to change . . . turn off the gas . . . get on top the furnace . . . lift out the old tube . . . hang a new one in its place . . . and the thin, rolled metal tubes actually last longer!

Quench tank pit unnecessary . . . Your Lindberg Carbonitriding Furnace is self-contained, including a built-in pitless quench tank . . . thus you avoid costly excavation and piping. But more important, this built-in quench tank minimizes distortion . . . quenching takes place within the furnace structure, by means of a vertically operated elevator. Heated charges are never exposed to the air . . . as is the case when work is transferred from the heating chamber to a separate quench tank. Uniform case depth is assured because each charge automatically remains at heat the same length of time.

Purge chamber . . . A specially designed chamber, built immediately above the quench tank and in front of the heating chamber, receives work load for purging prior to heating.

For full details ask for Bulletin 241

Lindberg Engineering Company 2451 W. Hubbard Street, Chicago, Illinois

LINDBERG FURNACES

AMERICAN CHEMICAL PAINT COMPANY

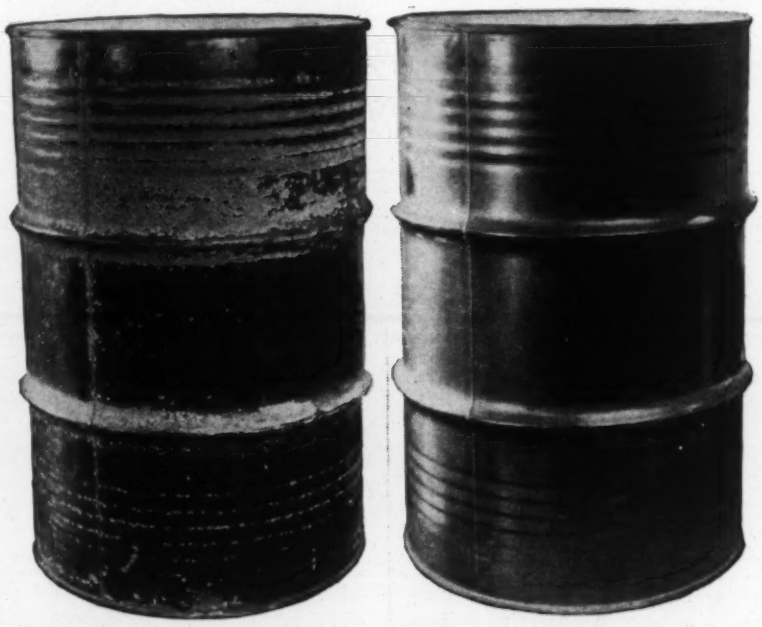
AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: HOW *GRANODIZING* PROTECTS STEEL DRUM SURFACES FROM RUST AND IMPROVES PAINT ADHESION

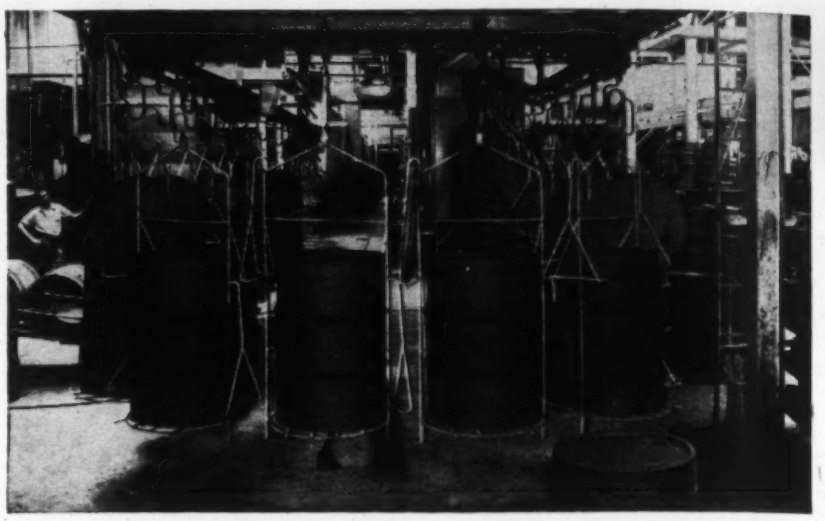
NEW DEVELOPMENT IN CONTAINER INDUSTRY

United States Steel Products Division, United States Steel Company is now producing grease-free, scale-free, rust-inhibited steel drums. A chemically clean metal surface plus a "Granodine"* non-metallic zinc phosphate coating insures maximum finish durability and underpaint rust-resistance. *Trade Mark Reg. U.S. Pat. Off.



ORDINARY PAINTED DRUM after a year of exposure to weather is badly rusted. Rust was very apparent after only one week.

U. S. S. RUST-INHIBITED DRUM of similar type shows absolutely no rust after same year's test.



Port Arthur, Texas, Cleaning Line

U. S. S. drums about to enter the 400 foot cleaning and treating line. Powerful impingement sprays directed at the fabricated shell, head, and bottom, insure that the entire interior and exterior of the drum will receive full cleaning and rust-inhibiting treatment.

THE PROTECTIVE CHEMICAL TREATMENTS

The Granodizing process embodies the following steps:

1. Grease and dirt removal
2. Full scale removal, after welding the side seam
3. Zinc phosphate coating with "Granodine"
4. Acidulated rinsing in "Deoxylyte" solution

ADVANTAGES OF GRANODIZED STEEL DRUMS

These new phosphate-coated steel drums exhibit many advantages for companies using these containers.

They are chemically clean, "water-break free" inside, free of contaminating residues such as grease, oil, drawing and stamping compounds. When the familiar handkerchief test is applied to United States Steel Products' containers processed by their new finishing technique, no contamination of any kind is left on the cloth.

They are free of mill-scale. United States Steel Products is the first steel drum manufacturer to remove harmful mill scale completely ahead of the zinc phosphate coating stage.

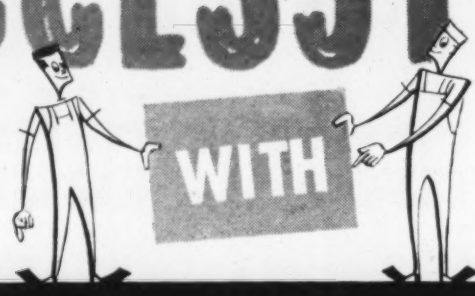
They are rust-inhibited with a zinc phosphate-coating. These new steel drums have the added advantage of a non-metallic, paint-bonding "Granodine" zinc phosphate coating. This has been standard practice for many years in the automotive and appliance industries for long-lasting paint protection and metal preservation.

CHEMICALS ACP PROCESSES

WRITE FOR INFORMATION ON "GRANODINE" AND ON YOUR OWN METAL PROTECTION PROBLEMS

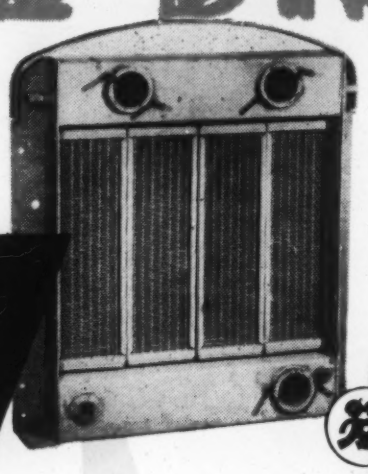
CHEMICALS ACP PROCESSES

SUCCESSFUL BRAZING



SILVALOY

LOW TEMPERATURE SILVER BRAZING ALLOY



PERFEX

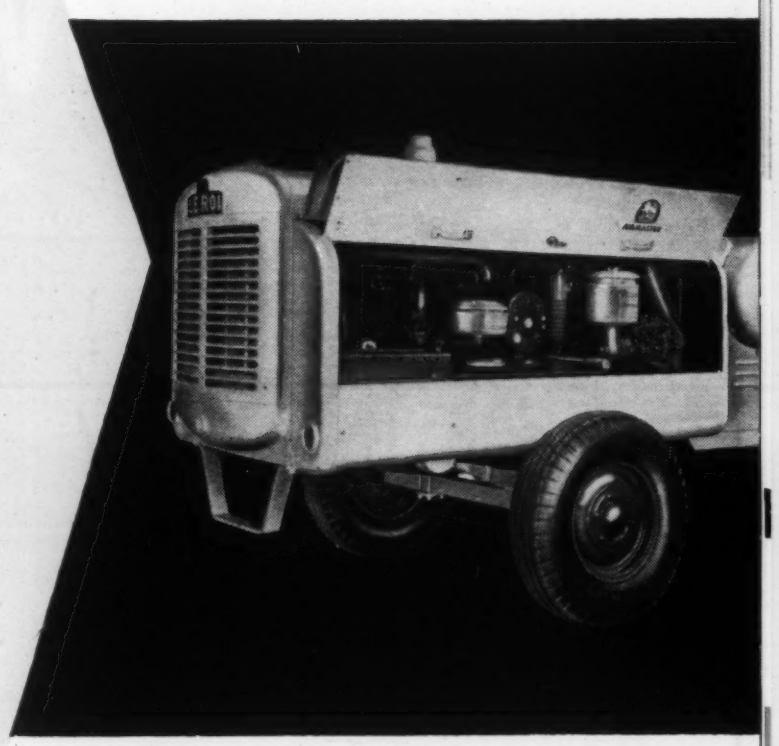
PERFEX INTERCOOLER
MODEL R-6428A

The excellent performance and service record of the Perfex intercooler used on LeRoi Compressors demonstrates the value of reinforced resistance to seam failures.

These units, which cool air under conditions of high temperatures and pulsating pressures are built with an extra safety-margin of strength that helps to protect the equipment owner against costly breakdown.

Silvaloy 50 and APW 1200 Flux were selected to provide required bonding strength in manufacture of Perfex intercoolers. Each seamless copper tube is Silvaloy-brazed in a strongly sealed joint to the top and bottom header sheets.

Low Temperature Silvaloy Brazing is helping to speed and simplify brazing production, lower costs and improve results for manufacturers in many fields. Call the Silvaloy Distributor in your area for complete information—or ask him for technical assistance. He will send a Silvaloy Technical Expert to your plant, without cost or obligation to you.



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LEROI AIRMASTER 210
FOOT COMPRESSOR

FREE: SEND FOR 48-PAGE BOOK "A COMPLETE GUIDE TO SUCCESSFUL SILVER BRAZING"

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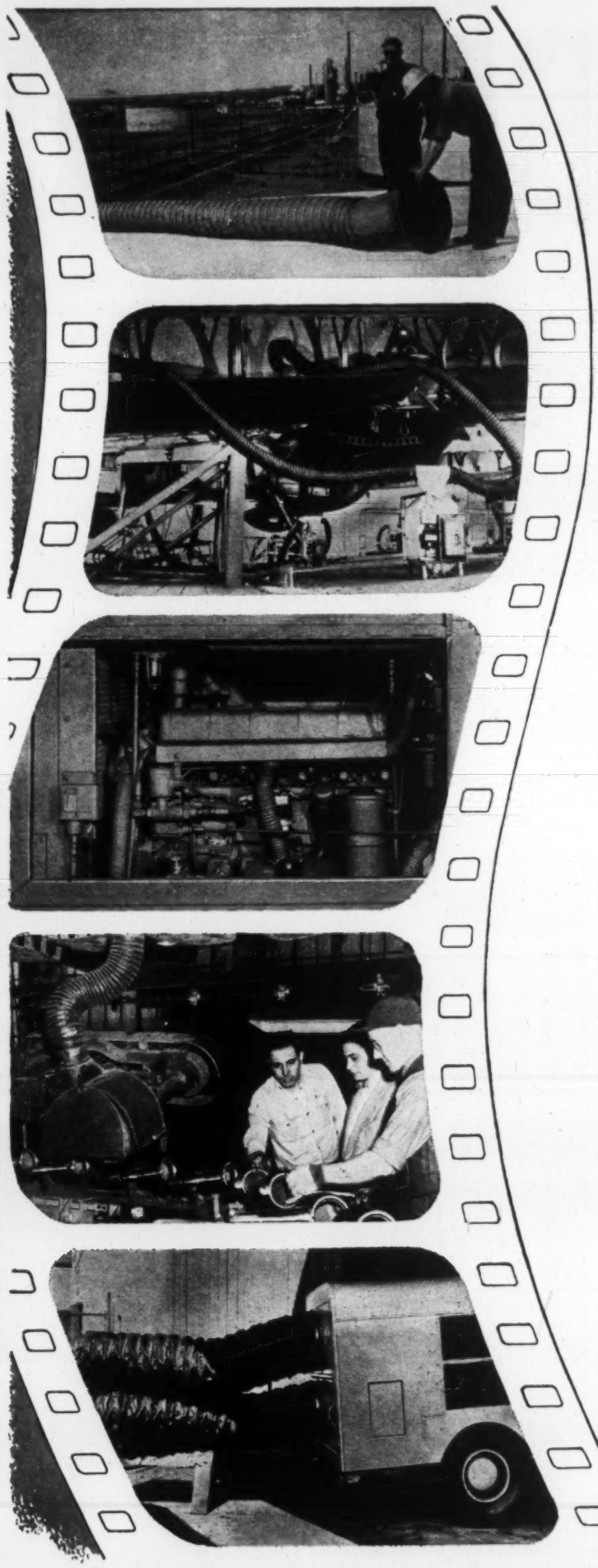

Where can you use this versatile tubing?

Flexible's line of tubing has proved itself in hundreds of applications as industry's most versatile ducting. Whether your requirements are air handling, fume removal, exhaust, dust collection, blowing, gravity . . . you can design with Flexible's line of tubing and be confident of better results!

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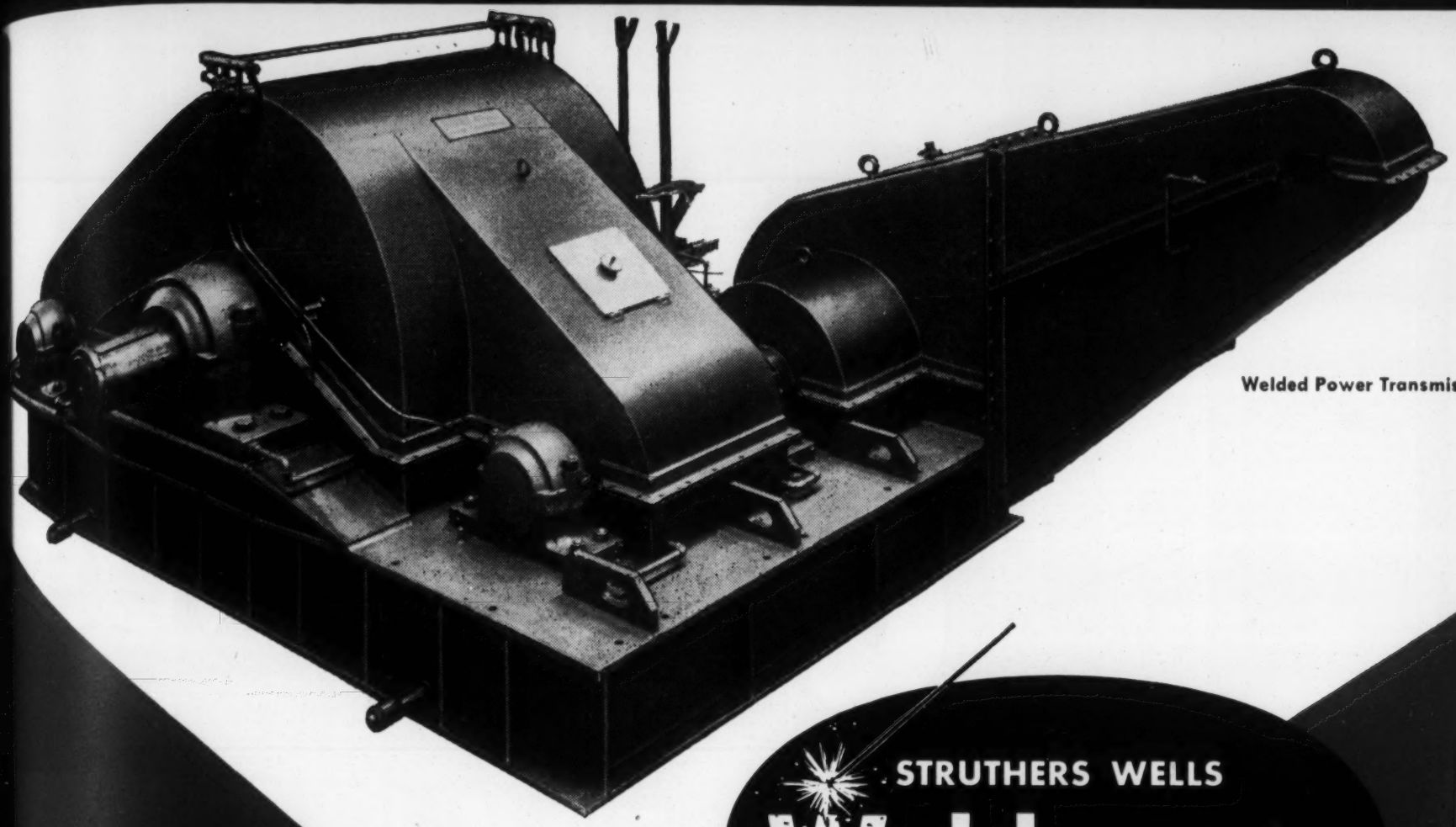
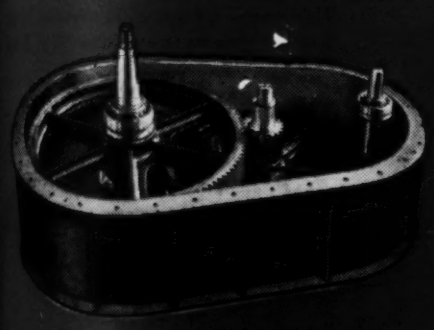


Welded Power Transmiss

Specify STRUTHERS WELLS Weldments



Welded Gear Housing

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Welded Base

and enjoy

- CORRECT DESIGN
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- HIGHER STRENGTH
- SAVINGS IN WEIGHT
- SAVINGS IN MATERIAL
- LESS MACHINING
- GREATER STIFFNESS

plus LOWER COSTS!

Struthers Wells' many years of experience, top engineering talent, modern equipment and productive ability are your assurance of highest quality weldments of every type, from small brackets to large housings. We fabricate plain weldments or complete matching assemblies. Consult us for partial or complete weldment units —and ask for our latest bulletin, "Struthers Wells Weldments."

STRUTHERS WELLS CORPORATION

TITUSVILLE, PA.

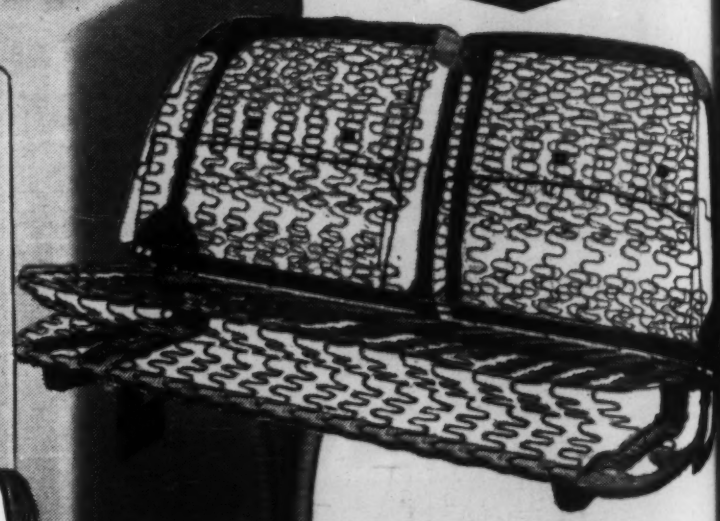
Struthers Wells

Service life increased

60 times

The Zig Zag Wire Forming Machine is used to make springs for automotive seats and furniture.

This view of an automobile seat frame shows how the Zig Zag springs are used.



Zig Zag Spring Company

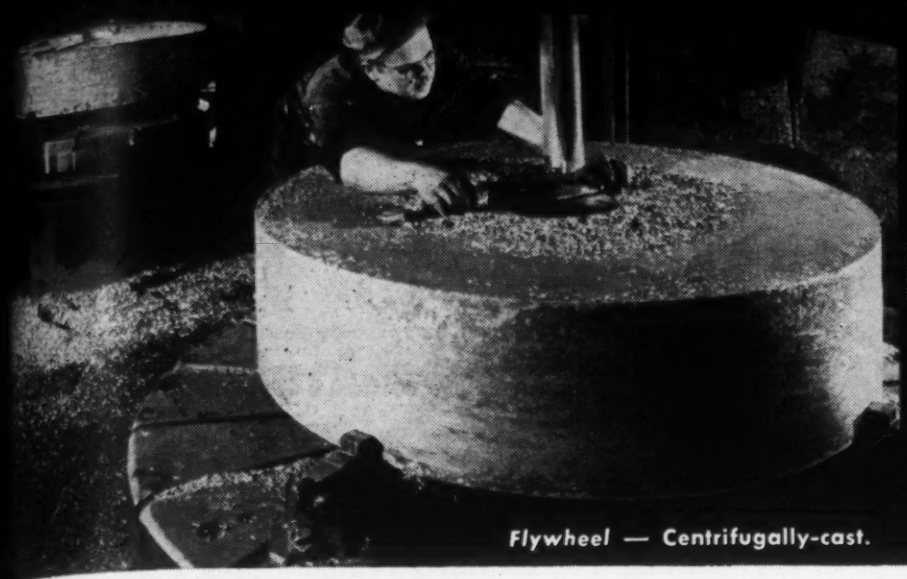
Los Angeles, California

Application: Slide block operating at 1000 cycles per minute and transmitting 4½ HP. A severe shock application that destroyed a roller bearing assembly after 4 days' operation and ordinary bearing bronze in less than a month.

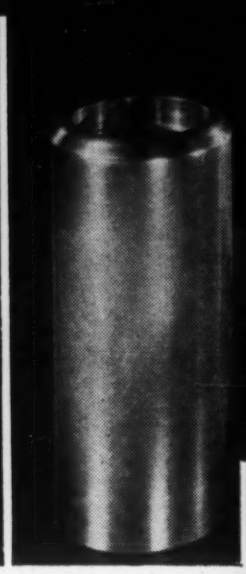
Solution: **AMPCO METAL**

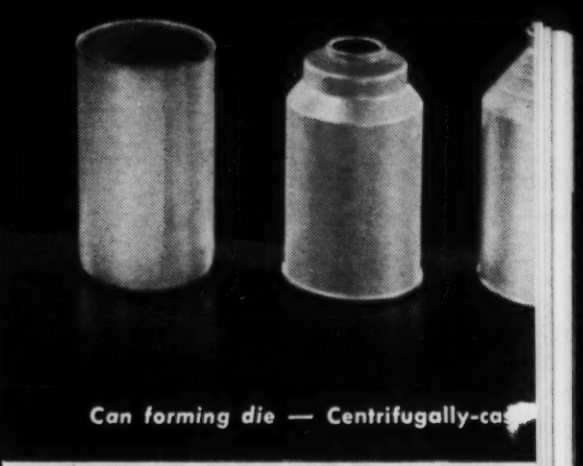
Results: Ampco Metal slide blocks have resisted wear for 5-years in round-the-clock service. Although close tolerances must be held, no adjustments due to wear have been required on Ampco Metal slide blocks during this period.

IT'S PRODUCTION-WISE TO AMPCO-IZE!



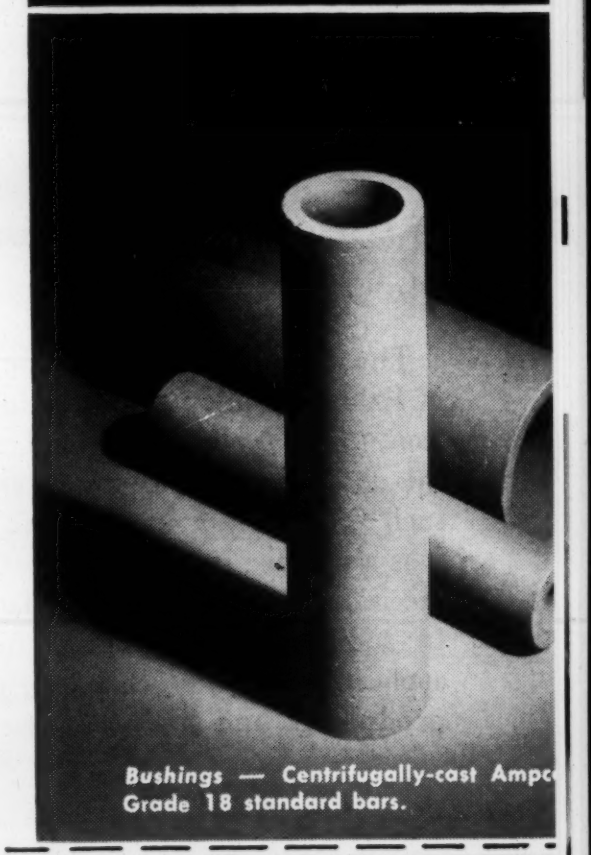
Flywheel — Centrifugally-cast.





Can forming die — Centrifugally-cast

Marine reversing gear component — Sand-cast.



Bushings — Centrifugally-cast Ampco Grade 18 standard bars.

—with AMPCO* METAL

Sixty times longer service life and still going strong. That's the story of the slide blocks used in Zig Zag Wire Formers. And the service is tough too — involves high speeds, severe shock loads.

As a result, 25 Ampco Metal parts are used in the Zig Zag Wire Former. The company reports that in 5 years no Ampco Metal part has been replaced or adjusted in any machine, despite high operating speeds and tremendous shock loading.

Mr. Harry H. Norman, Chief Engineer of the Zig Zag Spring Company, says that the long-wearing properties of Ampco Metal have contributed substantially to the success of their Spring Former.

Take a look at your wear problems. Perhaps Ampco Metal is the low-cost solution. Easy to use because it is available in practically any form required—sheet, plate, sand and centrifugal castings, forgings, bars, tubes, welding wire and electrodes. Consult your nearest Ampco field engineer or write us for further information.

*Reg. U. S. Pat. Off., Ampco Metal, Inc.

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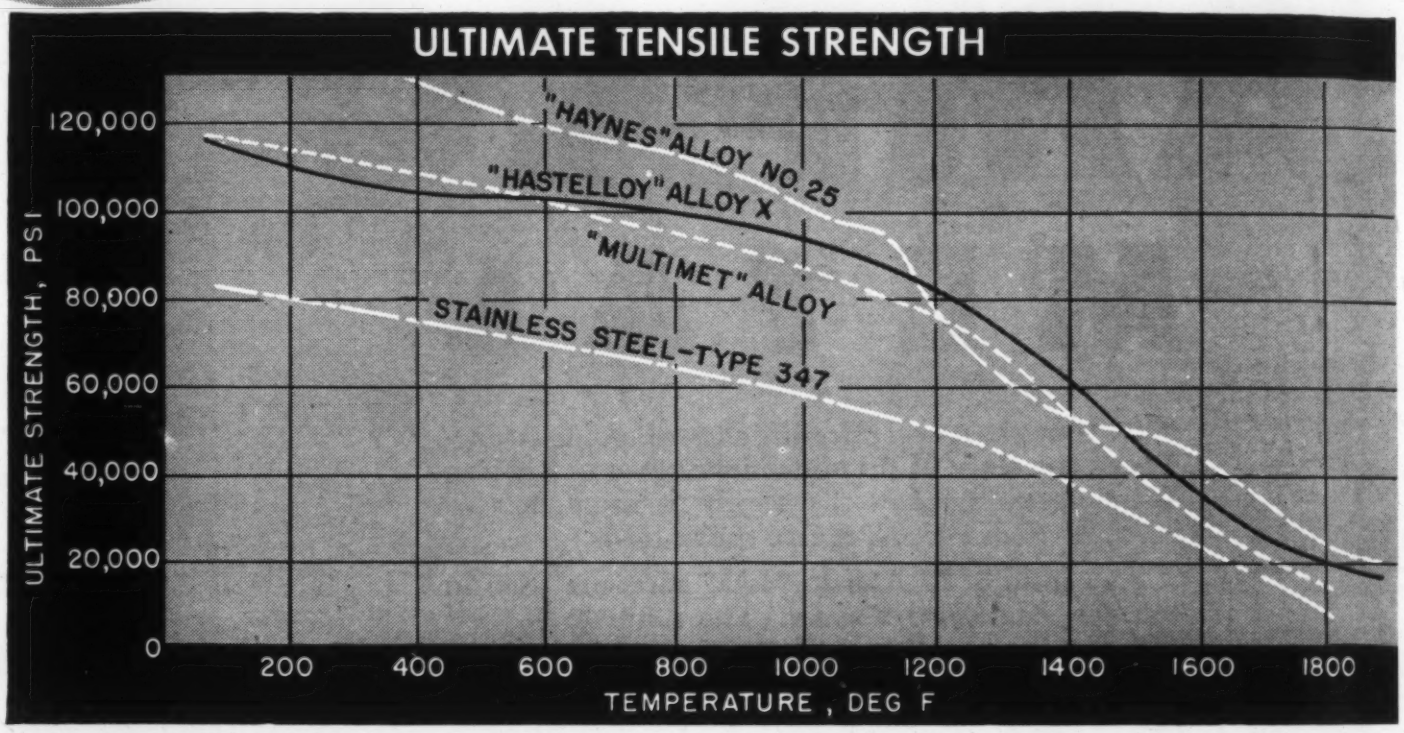
Trade-Mark
Alloy X

A New

"HAYNES" HIGH-TEMPERATURE ALLOY

High Strength at Elevated Temperatures
Excellent Oxidation Resistance
Low Strategic Alloy Content
Excellent Formability
Good Casting Characteristics



The excellent high-temperature properties of HASTELLOY alloy X—a new material that contains iron, nickel, chromium, and molybdenum—make this alloy a good choice for aircraft sheet-metal parts, such as cabin heaters, tail cones, and collector rings. It is also being tested for aircraft nozzle vanes, both precision-investment-cast and fabricated from sheet. In addition, it is designed for high-temperature applications in the chemical, petroleum, metal-producing, and heat-treating industries.

HASTELLOY alloy X has a relatively low content of strategic metals. Tests made so far indicate that alloy X has high-temperature properties comparable to those of other alloys containing a higher percentage of strategic metals (see graph).

The new alloy is available as sheet, plate, bars, wire, and precision-investment castings. For additional properties data, write to our General Offices in Kokomo, Indiana, for a copy of the new booklet "HASTELLOY Alloy X."

HAYNES
TRADE-MARK
alloys

"Haynes," "Hastelloy," and "Multimet" are trade-marks of Union Carbide and Carbon Corporation.

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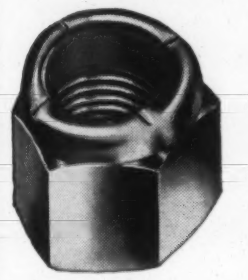
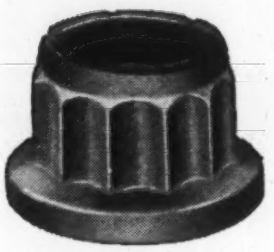
self-locking fasteners

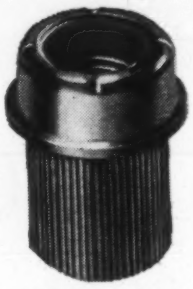
Elastic Stop nuts



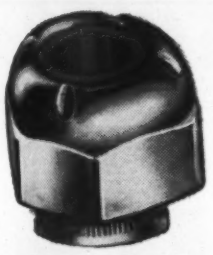
HEX NUT



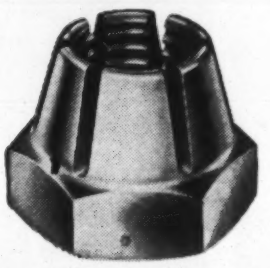
HIGH TENSILE NUT



SPLINE NUT

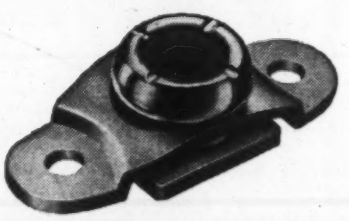


CLINCH NUT



1200° F. HIGH-TEMP. NUT

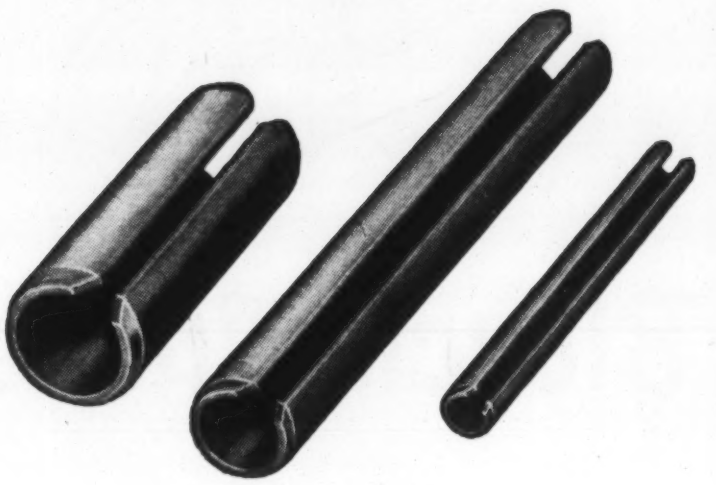
GANG CHANNEL NUTS



FLOATING ANCHOR NUT

Every major aircraft now being assembled relies on the vibration-proof holding power of ELASTIC STOP nuts. Only ESNA manufactures a complete line of all types and sizes of self-locking nuts.

Rollpins



dia. from 1/16" to 1/2"

Rollpins are slotted, tubular steel, pressed-fit pins with chamfered ends. They drive easily into holes drilled to normal tolerances, compressing as driven. Extra assembly steps like hole reaming or peening are eliminated. Rollpins *lock* in place, yet are readily removed with a punch and may be reused.

Cut assembly costs by using Rollpins as set screws, positioning dowels, clevis or hinge pins. Specify them in place of straight, serrated, tapered or cotter type pins.

ESNA® TRADE-MARK

ELASTIC STOP NUT CORPORATION OF AMERICA

ROLLPIN TRADEMARK

Mail Coupon for Design information

Elastic Stop Nut Corporation of America
Dept. N34-461, 2330 Vauxhall Road, Union, N. J.

Please send me the following free fastening information:

- ☐ Elastic Stop Nut Bulletin
- ☐ Rollpin Bulletin
- ☐ AN-ESNA Conversion Chart
- ☐ Here is a drawing of our product. What fastener would you suggest?

Name_____ Title_____

Firm_____

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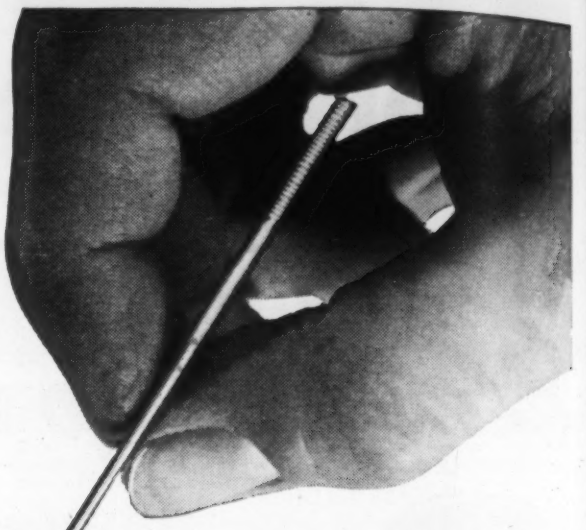
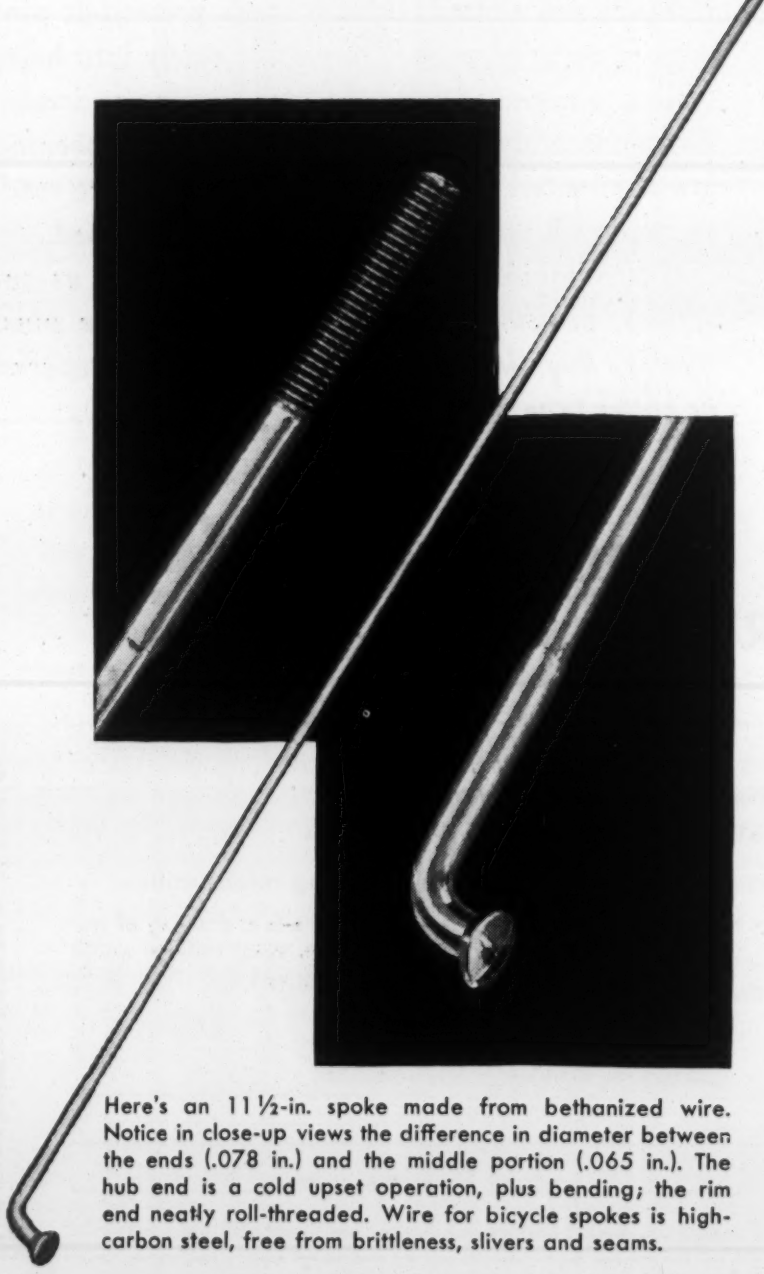
City_____ Zone___ State_____



Bicycle Spokes...Good Exercise for **Bethanized Wire**



Here's an 11½-in. spoke made from bethanized wire. Notice in close-up views the difference in diameter between the ends (.078 in.) and the middle portion (.065 in.). The hub end is a cold upset operation, plus bending; the rim end neatly roll-threaded. Wire for bicycle spokes is high-carbon steel, free from brittleness, slivers and seams.

From the moment it spins off the coil, wire used for bicycle spokes takes a beating. Forming operations call for swaging, upsetting, threading and bending. Later, as a hard-working spoke, the wire must shake off kicks, collisions and, toughest of all, corrosion.

Manufacturers choose bethanized wire for rugged jobs because it comes through severe fabrication without losing its smooth good looks or its ability to fight rust.

Bethanized wire's top feature is its zinc coating —99 pct pure, of uniform thickness, highly ductile, and tightly adhering to the steel base. Bend the wire, twist it, even draw it through a series of dies —the zinc doesn't crack, flake or peel. Rust finds no inviting thin spots anywhere along the wire.

Next time you have a difficult forming job or a corrosion problem, try bethanized wire. The nearest Bethlehem sales office will be glad to give you more information. Or write to us at Bethlehem, Pa.

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM STEEL

Hettrick table and chairs are outstanding uses of molded polyester resins and Fiber·Glass

Lynn Scott, nationally known home stylist and Director of Plaskon Home Arts Council, says, "This Hettrick table and chair set will grace any room. It has the permanent beauty of molded-in color with easy-to-clean, smooth contours. Lightweight and weather resistance make it ideally suited to indoor and outdoor living."

Designed by
J. M. Little & Associates

Molded by
Molded Fiberglass Co.

Manufactured by
The Hettrick Manufacturing Co.

The Hettrick chairs and table shown above point the way to exciting possibilities in design and material properties which you can put into your product whenever you mold with Plaskon Polyester Resins and Fiber·Glass.

Consider how *your* product will stand to benefit. Moldings that excel in strength, lightness, and durability can be achieved with Plaskon Polyester Resins and Fiber·Glass. Dimensional stability, flexural strength and resistance to common solvents and weathering are exceptional.

In addition, Plaskon offers Fiber·Glass roving with exclusive Garan-sizing which assures a higher degree of translucency and extra strength in the finished molding, through greater wettability.

For uniform quality of ingredients, as well as the benefits of Fiber·Glass roving with genuine Garan-sizing, check now with the one reliable *single source* for all materials . . . Plaskon. For information or technical assistance, write today to Plaskon Division, Libbey·Owens·Ford Glass Co., Dept. 443, Toledo 6, O.

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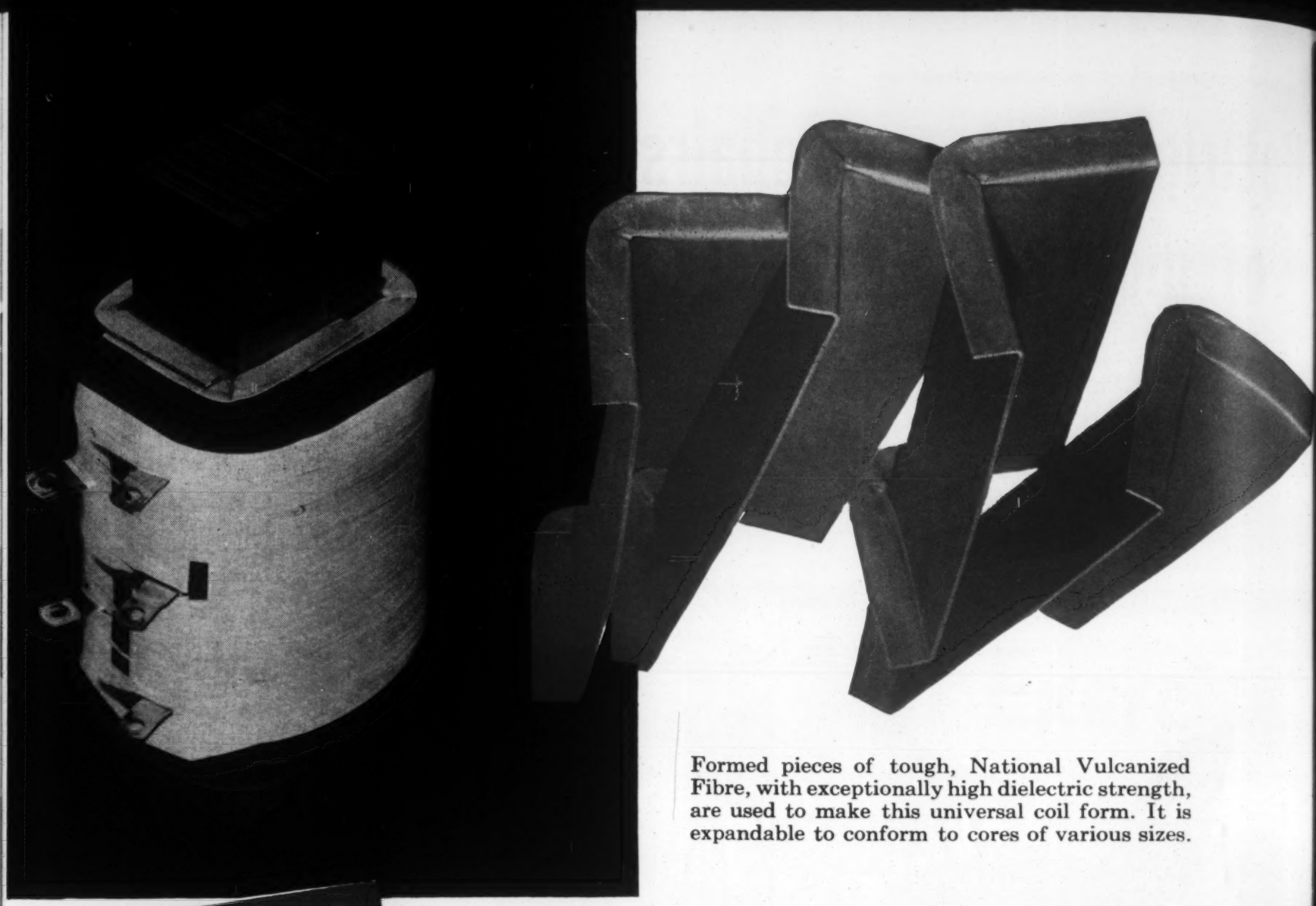


Formed pieces of tough, National Vulcanized Fibre, with exceptionally high dielectric strength, are used to make this universal coil form. It is expandable to conform to cores of various sizes.

NATIONAL VULCANIZED FIBRE

contributes to an improved product—in universal coil forms for Cutler-Hammer, Inc.

This practical use of National Vulcanized Fibre by Cutler-Hammer, Inc. in their wire spools is typical of the countless contributions National Vulcanized Fibre—*the material of a million uses*—makes to business and industry.

In the electrical field National Vulcanized Fibre has been the standard insulation for years. It has high dielectric strength and, when subjected to hot electrical arcing, it evolves neutral gas which extinguishes arc without "tracking." Many electric appliances find National Vulcanized Fibre to be the one best material for one or more of their parts.

National Vulcanized Fibre applications, both mechanical and electrical, are varied and extensive. In mechanical applications it is desirable because it possesses exceptional tensile and crushing strength, toughness, density and resistance to wear—coupled with ease of fabrication. It actually improves with age; for many mechanical purposes it is better, more durable than metal.

Available in various grades and colors; and in sheets, rods, tubes and special shapes. Write for detailed literature and engineering service information—

NATIONAL VULCANIZED FIBRE CO.

Wilmington Delaware

Offices in Principal Cities

Since 1873

National Laminated Plastics
nationally known—nationally accepted

SuVeneer®

STAINLESS CLAD METAL

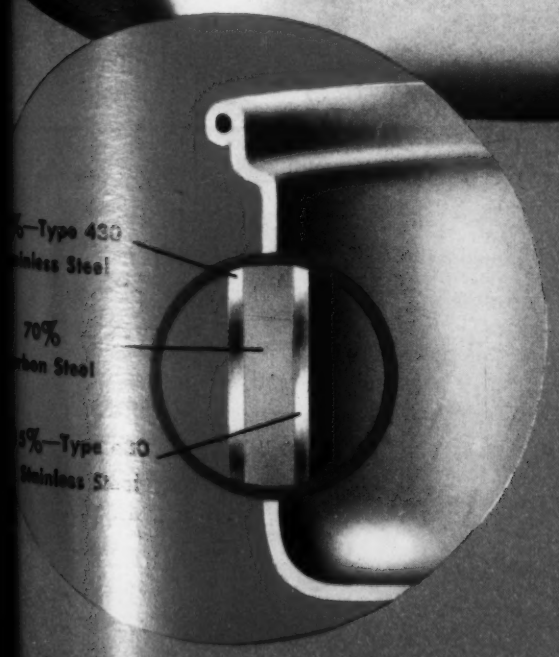
Wonderful for Cooking

★ Heats Easily

★ Heats Rapidly

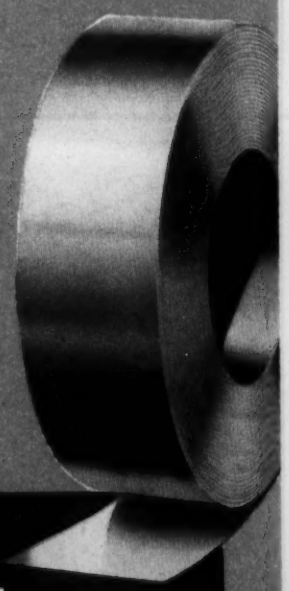
★ Heats Evenly

★ Ideal for your fabrication methods

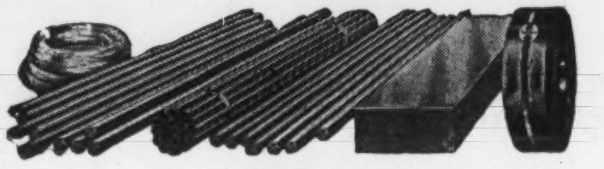


Fast, Even Heat Diffusion . . . No Hot Spots!

The word travels fast among consumers: get *stainless-clad* utensils now for better cooking . . . easy cleaning . . . stay-bright beauty! And the utensil maker says SuVENEER Stainless Clad Metal . . . for fabricating ease . . . for sales! Stainless both sides, mild steel in the center, furnished in coiled strip. Size, temper, finish to your specification. *Write.*



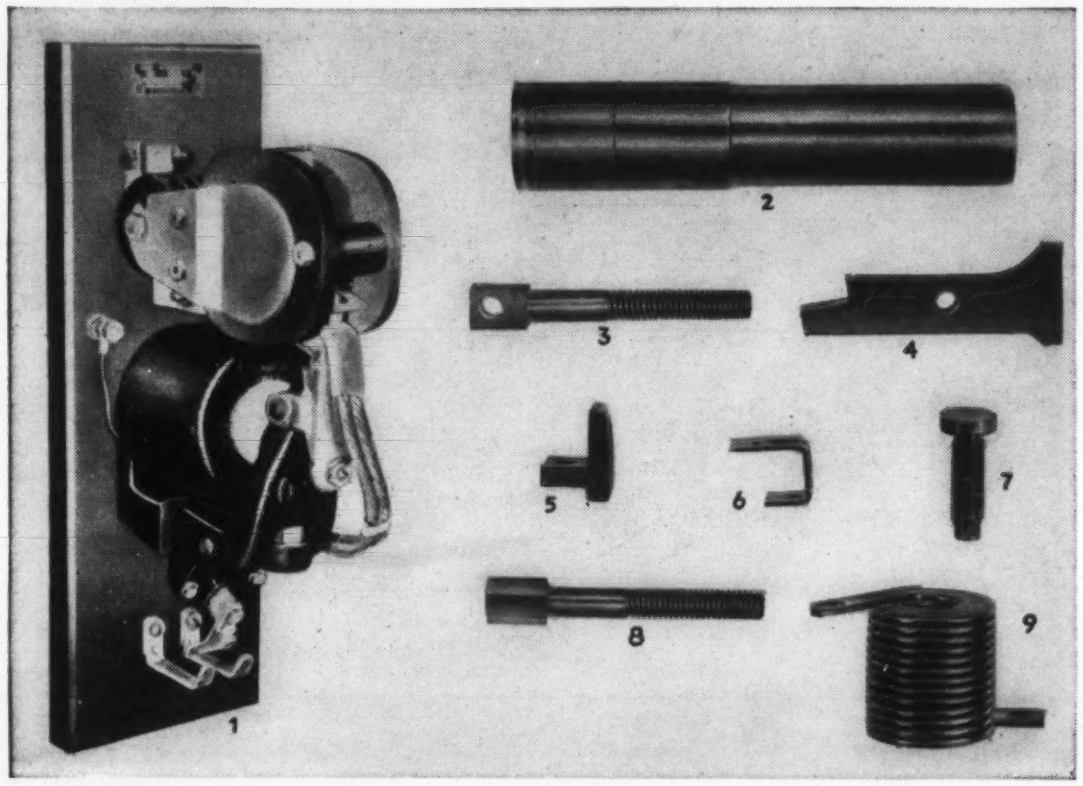
Superior Steel
CORPORATION
CARNEGIE, PENNSYLVANIA



BRIDGEPORT BRASS COMPANY

COPPER ALLOY BULLETIN

BRASS Bridgeport CO. MILLS IN BRIDGEPORT, CONN. AND INDIANAPOLIS, IND.—IN CANADA: NORANDA COPPER AND BRASS LIMITED, MONTREAL



Vari-Time Magnetic Contactor and copper-base alloy parts, courtesy The Clark Controller Co., Cleveland, Ohio.

Copper and its Alloys Ideal for Heavy Duty Contactors

D.C. Magnetic Contactors are used as motor starters, crane controls, press controls, furnace controls, etc. They must be capable of handling anywhere from 25 to 900 amperes, open and close rapidly with a minimum of arcing and burning, and withstand corrosion even when exposed to the elements. In order to meet these requirements, high conductivity copper and alloys such as free cutting brass and Phosphor Bronze are used to manufacture those parts which form the electrical circuit. Some parts such as the studs, contact tips and arc horns, which require machining, are less costly to produce because of less tool wear and spoilage when using copper or brass.

Vari-Time Contactor

Illustrated is a Clark Controller Vari-Time Magnetic Contactor (1) which contains a special core providing an adjustable time delay before closing after the coil has been energized. The timer (2) consists of a core tube machined from free-cutting brass bar stock. The I.D. of the tube is reamed smooth and has a tolerance of ± .0005". Other copper-base alloy parts are the core cap and valve seat, both machined from free-cutting brass and a washer made from commercial bronze. The assembled core is filled with a special oil of controlled viscosity, and then the core tube is sealed with the core cap which is soldered in place. The timing is adjusted by an adjustable stop stud on the front of the contactor which varies the gap between the armature and the front of the core. The entire VT Core is so designed and constructed as to give exceptionally long life. At various times, after years of hard service, Vari-Time cores have been taken apart and rigidly inspected with no appreciable wear or deterioration.

Other copper alloy parts used on the contactor are as follows:

Blowout Stud (3) — This stud is machined from high conductivity hard copper square bar stock and then silver coated. It holds the blowout coil to the slate and also provides a terminal for power connection.

Rear Contact Stud (4) — This extruded part is made from free cutting brass rod which is silver coated after being drilled and tapped. To this stud are connected the other end of the blowout coil, the stationary contact tip and the rear arc horn.

Contact Tips (5) — A heated billet of high conductivity copper is forced through a die producing an oversized cross-section of the tip. This extrusion is then cold drawn through a sizing die which also imparts the correct hardness to the copper. Two contact tips are used on each contactor.

Front Arc Horn (6) — The front arc horn is formed from a Phosphor Bronze Grade A (95% copper, 5% tin, 0.15% phosphorus) strip while the rear arc horn, not illustrated, is formed from a high conductivity copper strip. Both arc horns are silver coated. The horns extinguish the arc by lengthening it until it is broken.

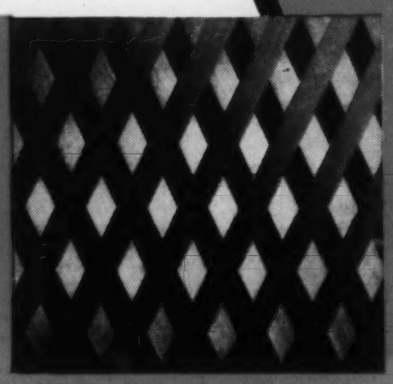
Stop Stud (7) — Machined from Phosphor Bronze Grade B-1 alloy, this stud acts as a stop for the contact arm.

Connector Stud (8) — This part is machined from high conductivity hexagon-shaped copper rod. It connects one end of the connector assembly to the slate, and also serves as a power terminal connection.

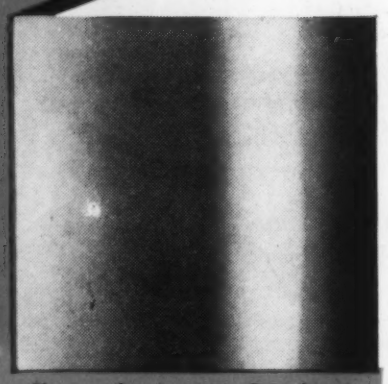
Before you decide what copper alloy to use for a particular application, many factors must be taken into consideration. Bridgeport Brass produces many alloys, each one with its own distinctive properties. Contact the nearest Bridgeport branch office for assistance with any of your metal problems. (9247)

NICKELOID AT WORK PRE-PLATED METALS

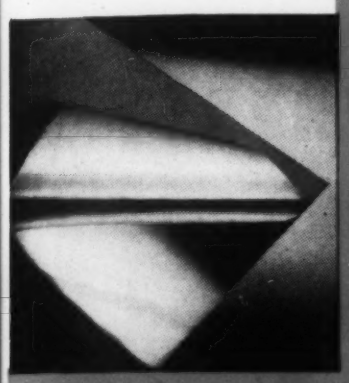
Mirror Back — ¼" stripe Chrome Steel is used. Decorative and durable.



This is diamond stripe pattern, available in any desired base metal.

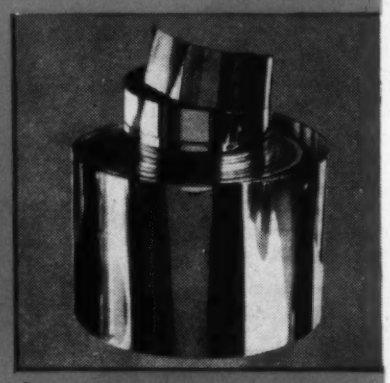


Chrome Steel, satin. Pre-plated. Chrome available in sheets, coils.

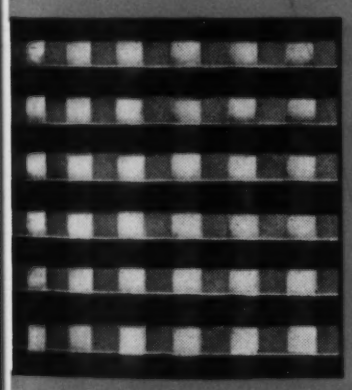


This is Mar-Not, paper adhered, to ease fabrication and handling.

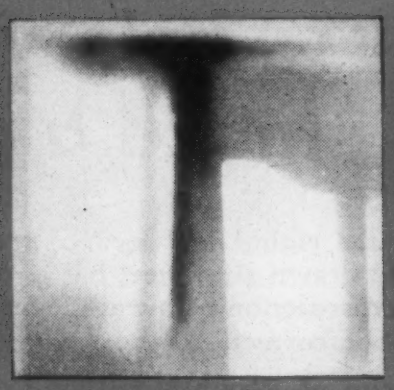
This is Copper plated steel. Lacquer coat recommended.



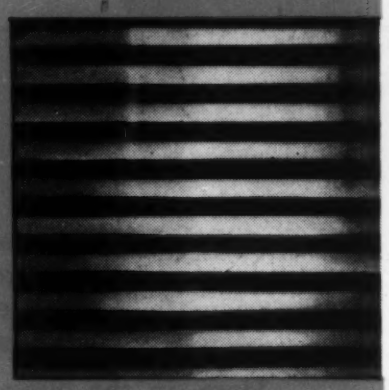
Steel base metals available in coils up to 24" wide.



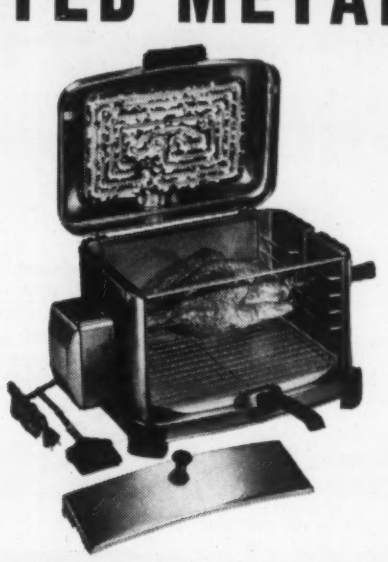
This is square crimp Chrome Zinc. Other crimps also offered.



Pre-plated metal, Chrome bright. May be plated one or two sides.



Horizontal stripe pattern; a striking, modern pre-plated design.



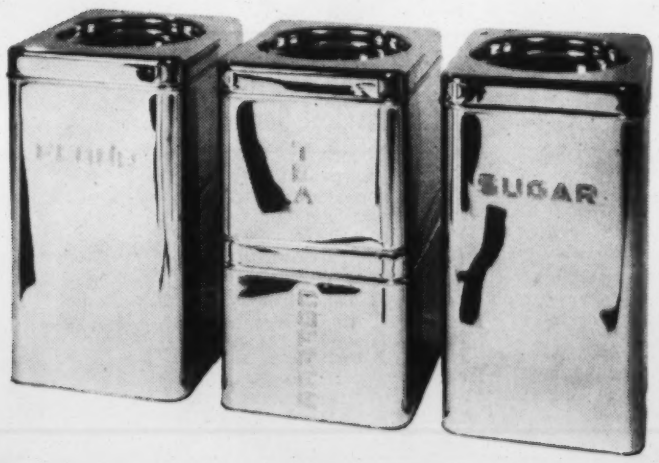
For broiling — a compact, beautiful electric infra-red combination Rotisserie and Broiler. Uses Nickeloid pre-plated Chrome Steel.

For door chimes — ivory plastic cover with satin brass or chrome tubes of pre-plated steel.

In the design and construction of your product, there may be practical possibilities for the adaptation of Nickeloid pre-plated metals. The basic soundness of pre-plating (finishing before fabrication) was never more apparent than today. This 55-year-old idea is being successfully proved on thousands of applications to be seen on the counters and shelves of the American marketplace.

BUILD *QUALITY* INTO YOUR PRODUCT

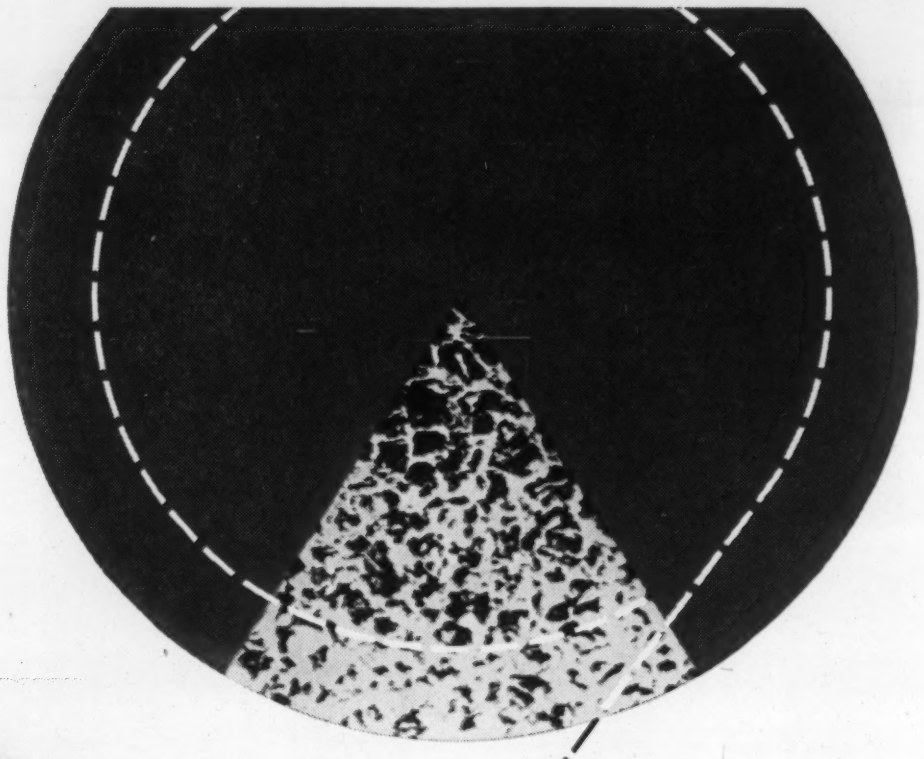
Kitchen canister set. A popular housewares item, made of Chrome Steel, bright finish.



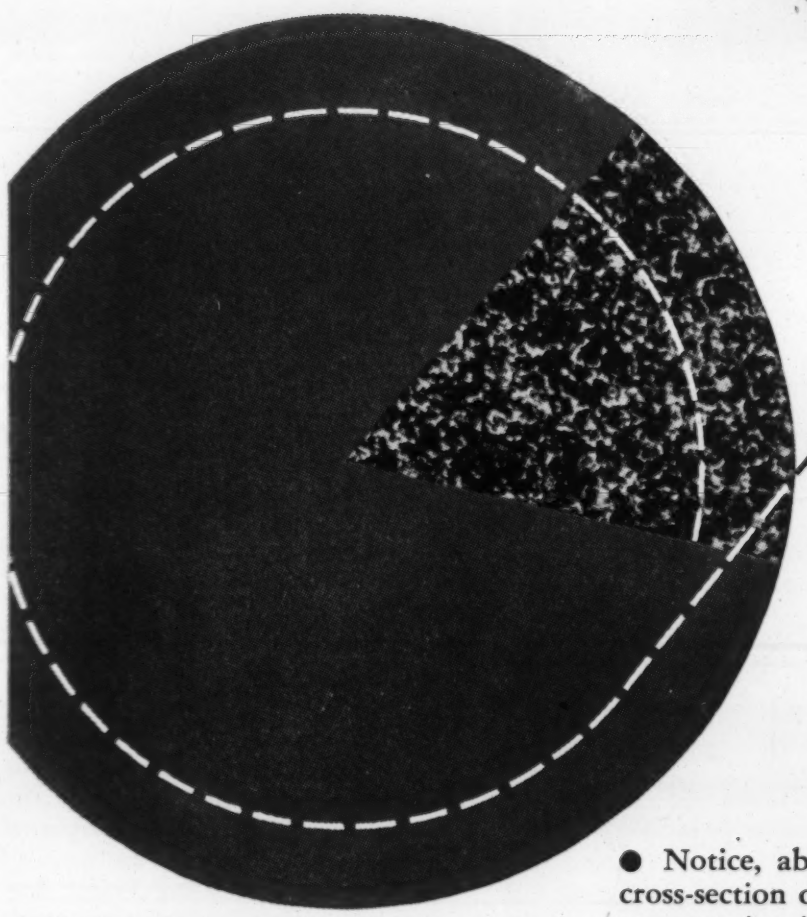
AMERICAN NICKELOID COMPANY

Established 1898

PERU 6, ILLINOIS



The "decarb" (light-colored) area in the ordinary heat-treated bar at right must usually be removed before parts can be made from the stock.



Notice that this Republic carbon corrected alloy steel bar has had full carbon content restored to outer edges by carbon correction.

HERE IS WHERE Republic Carbon-Corrected Alloy Steel Bars help you make a profit

● Notice, above at the right, the "decarb" area in the outer edge of the cross-section of a cold drawn alloy steel bar as ordinarily heat treated. Then compare it with the cross-section below at the left. Notice how the carbon has been restored by carbon correction even to the extreme outer circumference.

Here, in the outer rim of Republic Carbon-Corrected Alloy Steel Bars, is the profit-area for your machine tools . . . the part of the bar you don't have to machine away into chips and shavings.

Let our Republic 3-Dimension Metallurgical Service work with your metallurgists and production men to adapt Republic Carbon-Corrected Cold Drawn Alloy Steel Bars to your products. Your Republic Steel salesman can arrange for the Republic Field Metallurgist to call at your convenience.

LAB FIELD MILL

3-DIMENSION Metallurgical Service

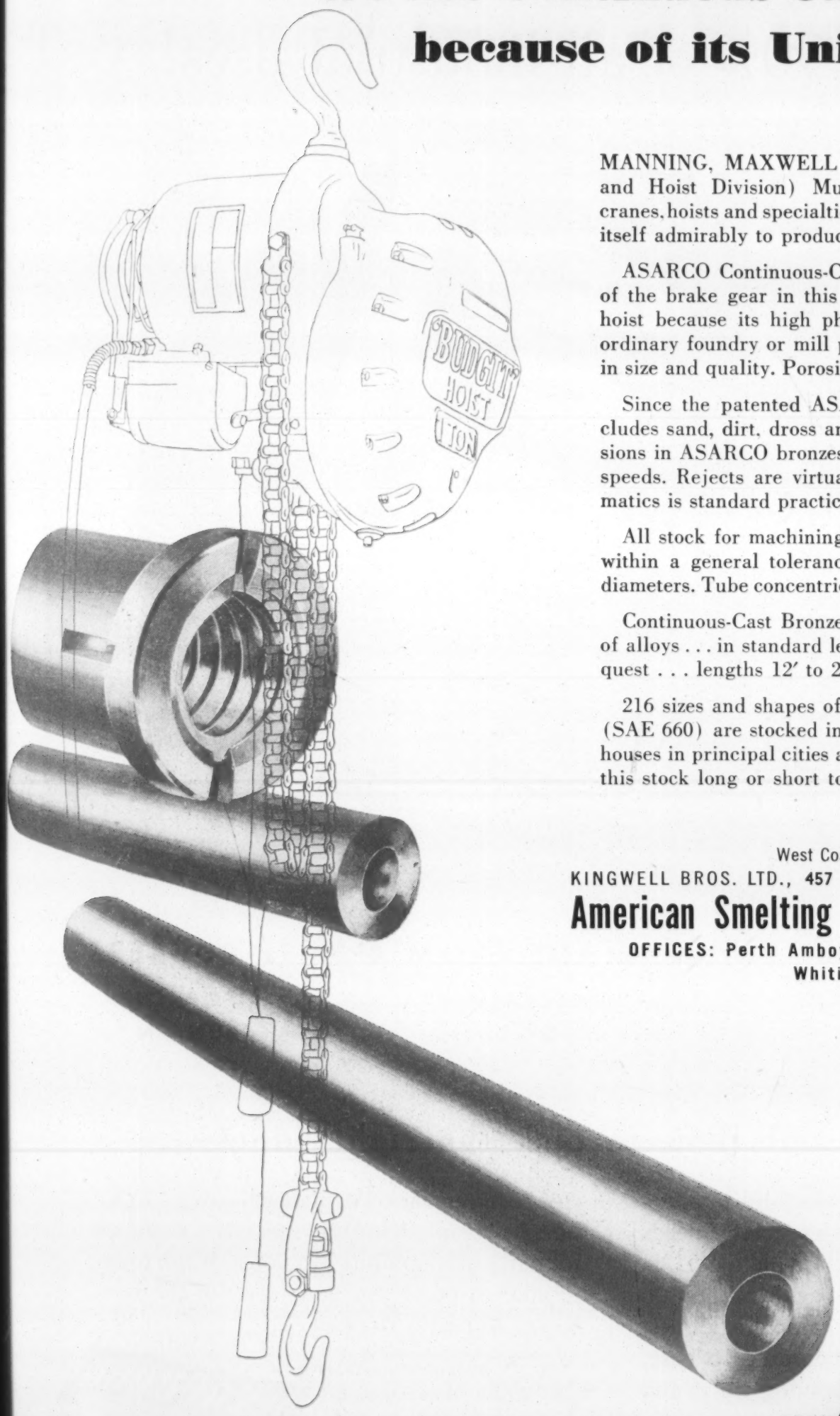
. . . combines the extensive experience and coordinated abilities of Republic's *Field, Mill* and *Laboratory* Metallurgists with the knowledge and skills of your own engineers. It has helped guide users of Alloy Steels in countless industries to the correct steel and its most efficient usage, IT CAN DO THE SAME FOR YOU.

REPUBLIC STEEL CORPORATION
Alloy Steel Division • Massillon, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N.Y.

Republic COLD DRAWN
REPUBLIC STEEL
ALLOY STEEL BARS

A Customer Reports:

"We use Continuous-Cast Bronze because of its Uniform Quality"



MANNING, MAXWELL & MOORE, INC., (Shaw-Box Crane and Hoist Division) Muskegon, Michigan, manufacturers of cranes, hoists and specialties, says also that ASARCO bronze lends itself admirably to production on automatic screw machines.

ASARCO Continuous-Cast Bronze is used for the gear center of the brake gear in this company's "Budgit" portable electric hoist because its high physical properties far exceed those of ordinary foundry or mill products. Stock is consistently uniform in size and quality. Porosity is non-existent.

Since the patented ASARCO continuous casting process excludes sand, dirt, dross and other impurities, there are no inclusions in ASARCO bronzes to injure tools or reduce high cutting speeds. Rejects are virtually unknown . . . machining on automatics is standard practice.

All stock for machining is Medart-straightened and furnished within a general tolerance of +0.004″ to —0.006″ on outside diameters. Tube concentricities are within 1.5% of wall thickness.

Continuous-Cast Bronzes are made to order in a wide variety of alloys . . . in standard lengths of 12′ . . . lengths 5′ to 12′ on request . . . lengths 12′ to 20′ by special arrangement.

216 sizes and shapes of standard Asarcon 773 bearing bronze (SAE 660) are stocked in 105″ lengths for convenience at warehouses in principal cities across the country. Distributors will cut this stock long or short to suit your needs.

West Coast Sales Agent:
KINGWELL BROS. LTD., 457 Natoma Street, San Francisco, Calif.

American Smelting and Refining Company

OFFICES: Perth Amboy Plant, Barber, New Jersey
Whiting, Indiana

ASARCO
CONTINUOUS-CAST
RODS · TUBES · SHAPES
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10 U. S. Royal adhesives cover 90% of all industrial uses!

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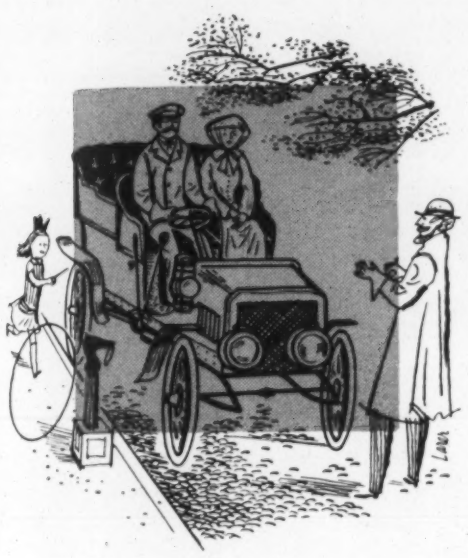
There's a "golden" gear in your new Studebaker!



You'll never see and never hear that "golden" silent Celoron timing gear running in your Studebaker, but it gives your car good performance and reliable ignition.

Let's go back to when cars were carriages and all gears were metal, regardless of their function, or the amount of noise they made.

The plastics industry was fresh out of the mold. Vulcanized Fibre (like we've made since 1895) was a relatively new product. The thought of using a laminated thermosetting material sent chills through the hardened arteries of job-conscious engineers.

Up front in every car were two metal gears, working off the camshaft, to regulate the ignition timing action of the car. They whined and rattled. They wore, and car owners swore at the high cost of replacement and at that infernal gear clatter.

Along came some enterprising gents with an idea, and a new C-D-F material: CELORON, a golden, laminated material made from selected canvas duck and a special phenolic resin. They boldly suggested that a gear cut from Celoron sheet stock could replace one of the metal timing gears . . . and that it would eliminate this "up front" engine noise.

By gosh, they were right! Celoron gears worked. Noise was eliminated; gears ran better and lasted longer. Lubrication was no problem. Car builders with imagination (Studebaker was one of the first), hopped on the Celoron bandwagon.

Today Celoron timing gears are used in every Studebaker and are the finest, strongest gears available. Gear timing has proven superior to other methods tested by the company.

A Celoron gear is individually molded! The rim is made of layer upon layer of woven cotton fabric that has been resin-impregnated, then laminated. These layers are laid edgewise to give each tooth the same high strength. Studebaker did not copy other gear designs . . . they use an exclusive spoke construction which reduces the noise level below that of any other design, and also provides increased flexibility for excess torsional stresses. Each gear and its metal mating gear is precision cut and minutely inspected. The owner of any Studebaker can be certain that every effort has been made to insure long life and smooth running of these vital Celoron gears.

Studebaker builds the best because they have engineering imagination. They are not limited to old materials, old ways. The Celoron timing gear, made from a golden, strong, silent material, in your new Studebaker is proof of this.

THE NAME TO REMEMBER CDF ...FOR CELORON TIMING GEARS

Continental-Diamond Fibre Company

NEWARK 25, DELAWARE

How to make air conditioners tighter and quieter

Tests prove that the effectiveness of sound damping pads is very dependent upon how the pads are bonded into place. Better noise suppression on your air conditioners, then, may come from a simple production line switch in adhesives.

Maximum sound conditioning, however, is easier to get when you use adhesives and damping pads especially designed to work together. You'll find such a team in Armstrong's Adhesives, Sealers, and Sound Deadening Felts.

There's an Armstrong's Adhesive, for example, that is halide-free. It won't cause false alarms in leak detection apparatus. Another has the heat resistance you need if you apply damping pads before lacquering and baking. It also offers low cost, high immediate tack, and fast drying.

The sealers in the Armstrong Line are equally well adapted to your production line. One example is a sealer you can water-test as soon as it's put on.

Armstrong's Felt can help, too. It is both kneaded and corrugated. This dual treatment, plus inherent mass, gives high damping efficiency at low cost. Die-cut parts are available.

To check what these industry-tailored materials can do to make your air conditioners tight and quiet, call or write the Armstrong Cork Co., 9304 Reservoir St., Lancaster, Pa.

for

ARMSTRONG'S

ADHESIVES • COATINGS • SEALERS

by the makers of Armstrong's Linoleum

Keynoter Series furniture designed by Edmond J. Spence for the Warren Furniture Manufacturing Co., Paterson, N. J.

Table-based utility cabinet has four drawers, each molded of black BAKELITE Phenolic Plastic, faced with "FORMICA," combining durability with good looks.

Utility cabinet features four drawers of black BAKELITE Phenolic Plastic to complement an adjacent door of wood. They are easily cleaned, strong, smooth-working.

ONE-PIECE MOLDED PLASTIC DRAWER KEYNOTES NEWEST FURNITURE DESIGN

Designers of contemporary furniture are looking to contemporary materials to express their ideas. Latest proof of their success is this drawer molded of BAKELITE Phenolic Plastics.

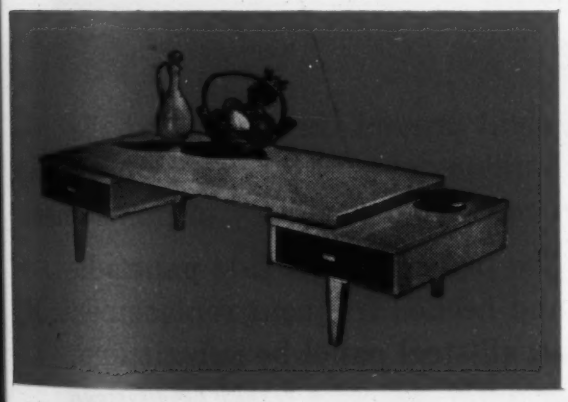
It has several advantages over conventional drawers—in design, manufacture, and use. With its rounded corners and absence of seams, it's easier to clean. Precisely molded, smooth, light in weight, it fits perfectly in place, slides open quietly and effortlessly. It withstands moisture and heat – won't swell, crack, or warp in normal use. Fast mass-production keeps its cost low.

The drawer illustrated is a rich ebony black that harmonizes with the modern woods—ash-blond korina, limed oak, dark mahogany. It could also be molded in other colors, such as red, brown and simulated wood-effects. The soft satin finish is acquired in the molding operation. The drawer can also be faced with wood or other materials.

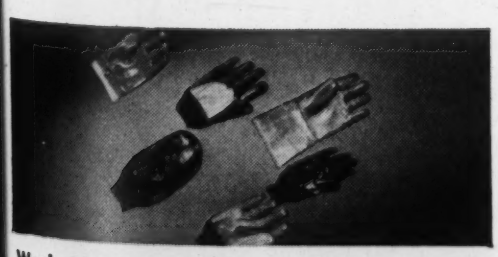
BAKELITE Phenolic Plastics have properties that inspire fresh, new designs. They are readily applied to the production of large-size moldings, of which cabinets for air conditioning units and television sets are typical. You, too, can profit through the use of these materials. BAKELITE engineers can help you. Write Dept. PH- 17.

BAKELITE
TRADE-MARK
PHENOLIC PLASTICS

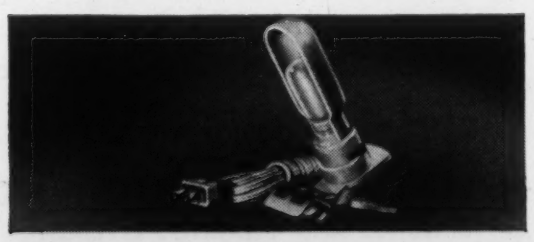
BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corp.
UCC
30 East 42nd St., New York 17, N. Y.



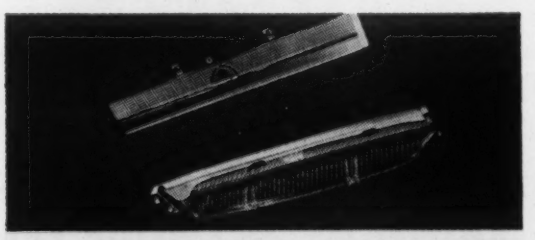
Adjustable cocktail table with two drawers of BAKELITE Phenolic Plastic, in rich self-contained ebony finish. They contrast handsomely with the soft-grained wood.



Work Gloves coated with VINYLITE Brand Resins outlast other types 10 to 1. They withstand abrasion of wire, steel, concrete blocks, wood. Resist chemicals, oil, water. Stay flexible, give sure grip. By Plasticote Glove Co., Milwaukee, Wis.



Housing and Shade for Klip-Lite that fastens where needed, are molded of BAKELITE Phenolic Plastic for light weight, ease of manufacture, good electrical properties. By Cable Electric Products Incorporated, Providence, R. I.



Door Shelves for Servel "Automatic Ice-Maker" refrigerator are made of BAKELITE C-11 Plastic, which provides strength, toughness, sharp detail, ease of cleaning, and resistance to food acids, oil, temperature extremes. Molded by Kusan, Inc., Nashville, Tenn.

See what adhesives are doing today!

Saving one company $400,000 a year

Corrugated steel sheet secured to steel plates by 3M adhesive

Diesel locomotives must work right around the clock, and the vibration encountered in their millions of operational miles makes it vital that all parts be designed to withstand plenty of punishment.

One manufacturer found that the plywood-steel side panels he was using, were deteriorating and needed frequent replacement. His design section suggested that an all-steel panel be substituted, and further study revealed that *a 3M adhesive could be utilized to hold the panel sections together.*

The new panel proved stronger, more resistant to vibration and torsional stress, and preliminary cost studies indicate that *the new style panel will save over $400,000 a year in manufacturing costs.*

See what adhesives can do for you . . .

If you're interested in making better products at lower cost, look into 3M adhesives and sealers. For more information contact your 3M representative, or write Dept. 64 for a brochure describing applications.

3M COMPANY

ADHESIVES · COATINGS · SEALERS

MINNESOTA MINING AND MANUFACTURING COMPANY

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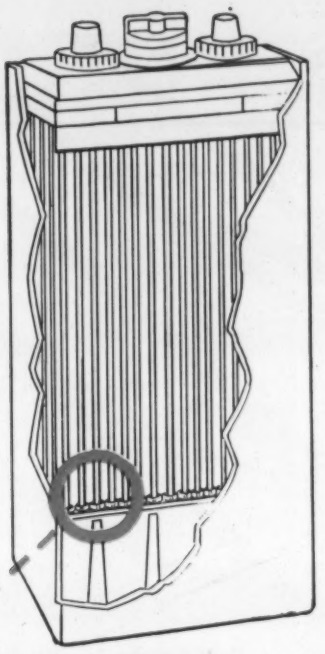
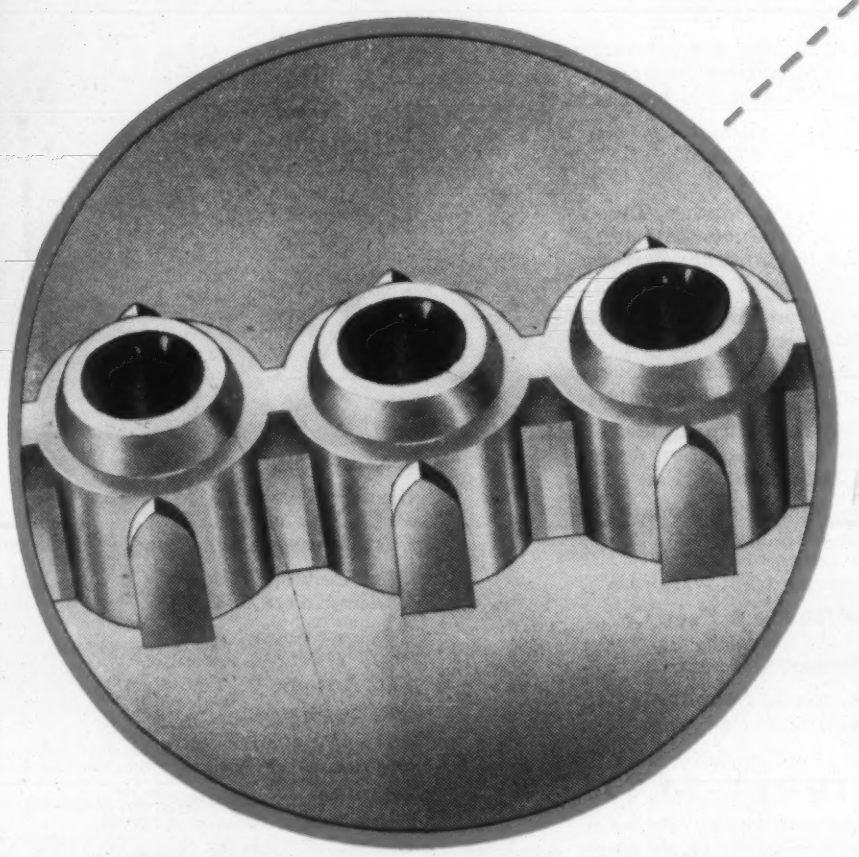


Battery tube sealers of acid-resistant DU PONT "ALATHON"*



Sealers molded for The Electric Storage Battery Co., Philadelphia, by Bachman Bros., Philadelphia, and Amos Molded Plastics, Edinburg, Ind.

*REG. U. S. PAT. OFF.

DU PONT
REG. U. S. PAT. OFF.
BETTER THINGS FOR BETTER LIVING
... THROUGH CHEMISTRY
Polychemicals
DEPARTMENT
PLASTICS • CHEMICALS

lengthen working life of industrial storage batteries by reducing leakage of active material

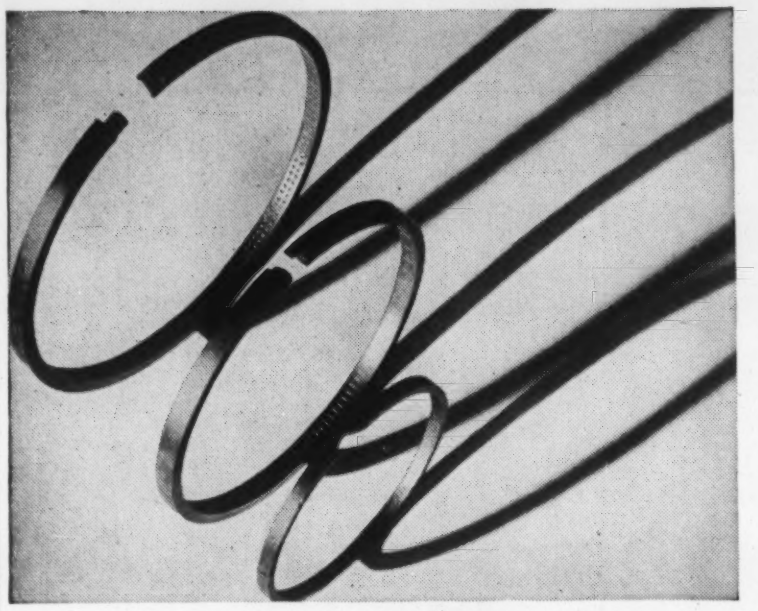
A new feature of the Exide-Ironclad industrial battery is positive-plate tube sealers made of Du Pont "Alathon" polythene resin. They reduce the previous low loss of active material by 50% . . . contribute to longer useful battery life. These permanent, non-corroding sealers also insulate the bottom of the plates . . . prevent short circuits.

This is another example of improved performance made possible by the outstanding properties of "Alathon." Its resilience insures a tight fit where the sealers cap the plates—reducing loss of active material and cushioning the plates as well. And "Alathon" is unaffected by electrolyte or electrolytic action. The intricately shaped sealers are economically mass-produced by rapid injection molding.

The excellent electrical, chemical and mechanical properties of Du Pont "Alathon" have led to its use in such varied applications as flexible tumblers, toys, squeeze bottles, and insulation for TV lead-in wire, and police and fire-alarm cable.

Perhaps Du Pont "Alathon" can help you improve or develop a product. We'll gladly suggest suppliers of molded parts or work with you in developing new applications. For full information, write:

E. I. du Pont de Nemours & Co. (Inc.)
Polychemicals Department,
Room 114-A, Du Pont Building
Wilmington 98, Delaware



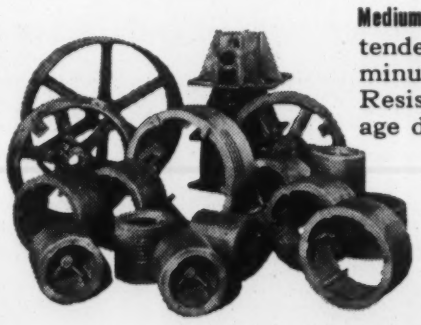
Light Castings . . . These piston rings are produced in Ni-Resist for engines used in corrosive service.

Investigate NI-RESIST . . .

No other cast metal provides such a unique combination of useful engineering properties

NI-RESIST® is available nationwide in 5 basic types to meet a variety of industrial demands: resistance to corrosion, heat and wear; strength and toughness; good machinability; high electrical resistance and non-magnetic characteristics . . . as well as heat conductivity and controlled thermal expansion.

At the present time, nickel is available for the production of Ni-Resist and other alloys containing nickel, for end uses in defense and defense supporting industries. The remainder of the supply is available for some civilian applications and governmental stockpiling.



Medium Castings . . . Free from tendencies to corrode, comminutor parts cast in Ni-Resist lengthen life of sewage disposal equipment.

Heavy Castings . . . Casing, outer column and discharge head of this 14-ton pump are cast in Ni-Resist for resistance to salt water and other corrosive media.

SOURCES OF SUPPLY FOR NI-RESIST CASTINGS

EASTERN SECTION...

Abrasive Alloy Castings Co.
Bridgeboro, N. J.

American Abrasive Metals Co.
Irvington, N. J.

American Brake Shoe Co.
230 Park Avenue
New York 17, N. Y.

American Brake Shoe Co.
Engineered Castings Division
10 Mt. Read Blvd.
Rochester 11, N. Y.

American Chain & Cable Co., Inc.
Acco Casting Division
Reading, Pa.

The Baldwin-Lima-Hamilton Corp.
Eddystone Division
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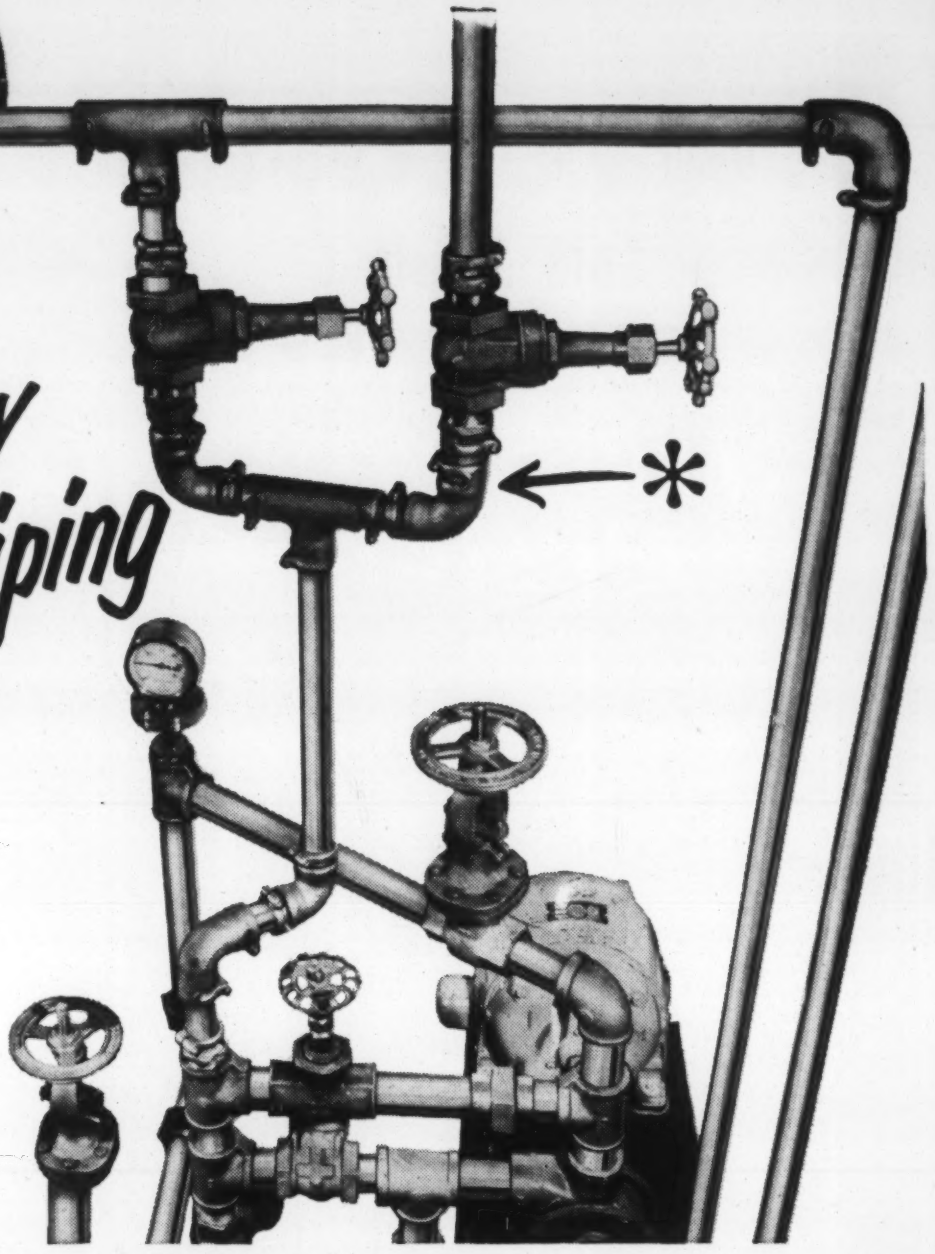

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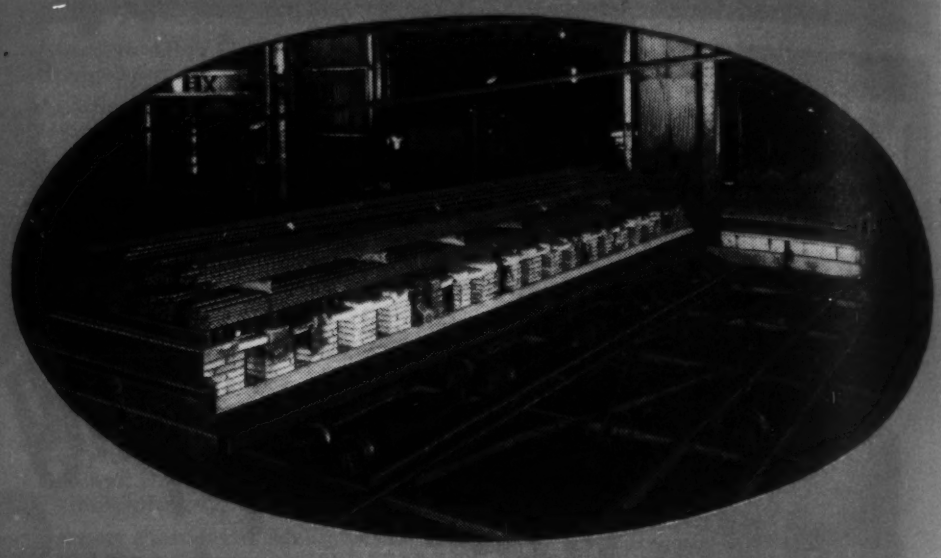

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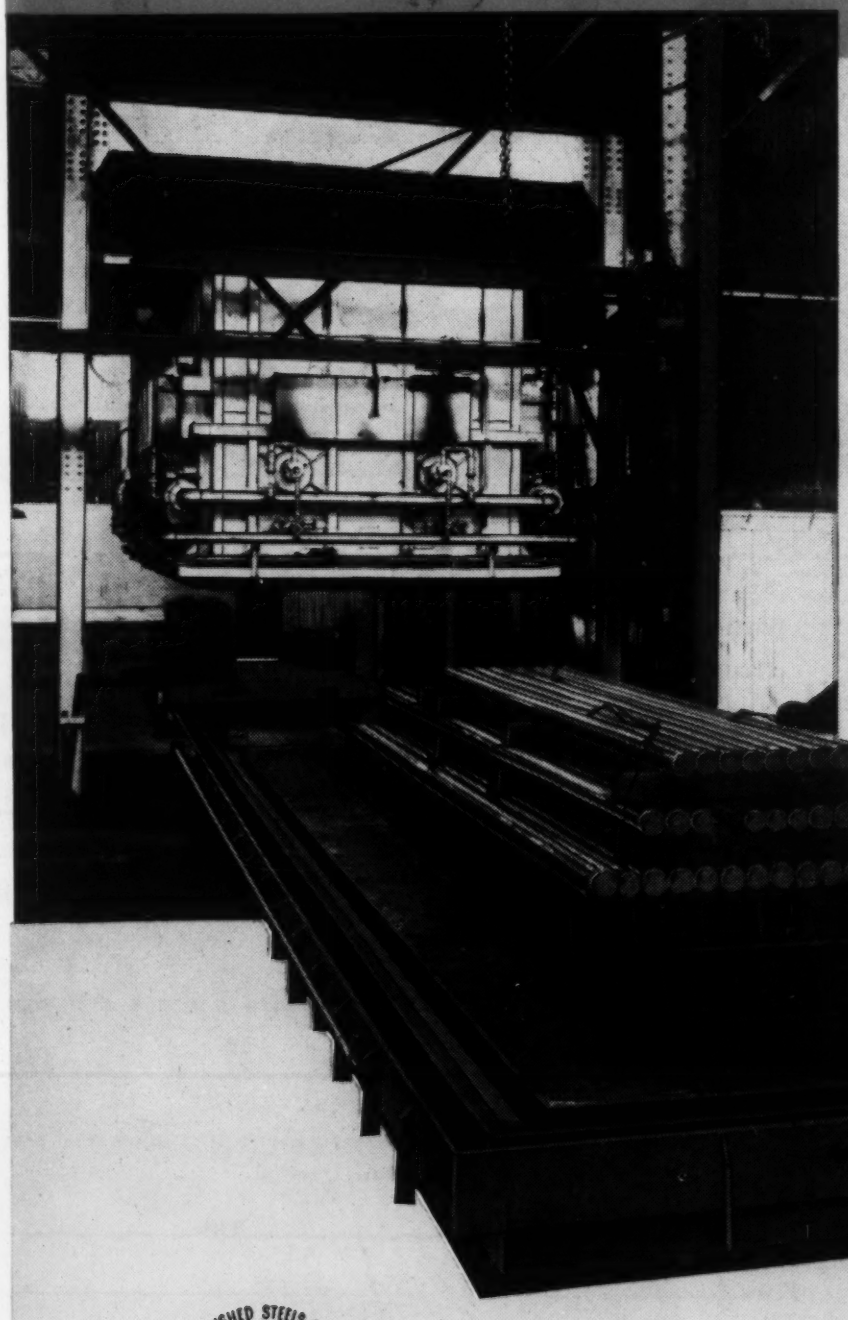

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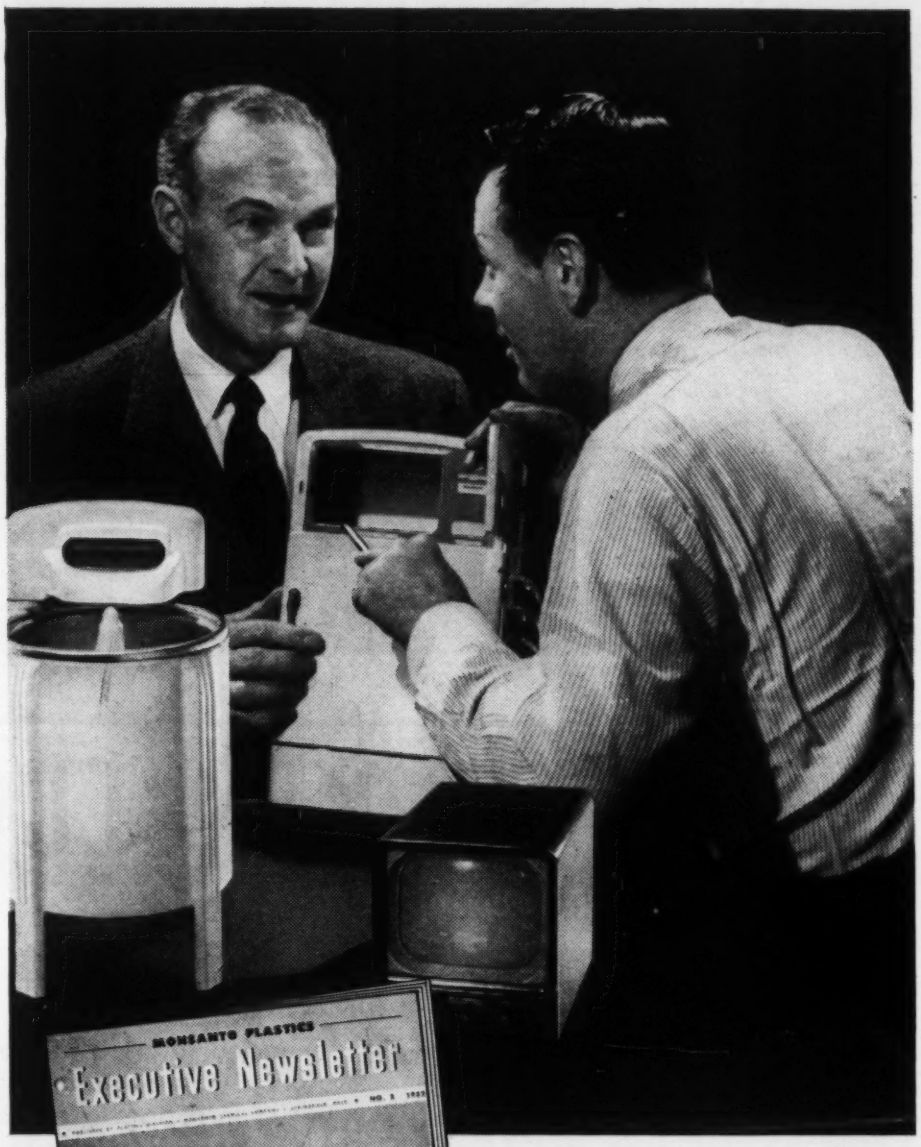

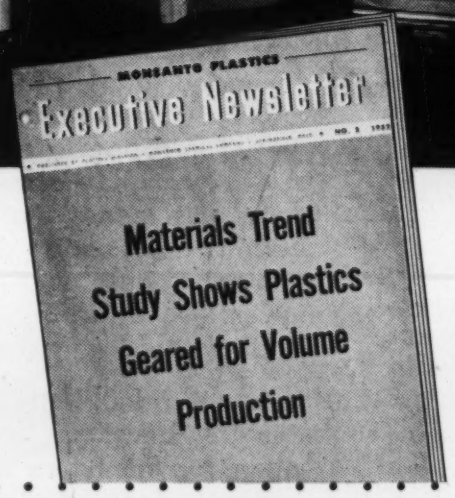

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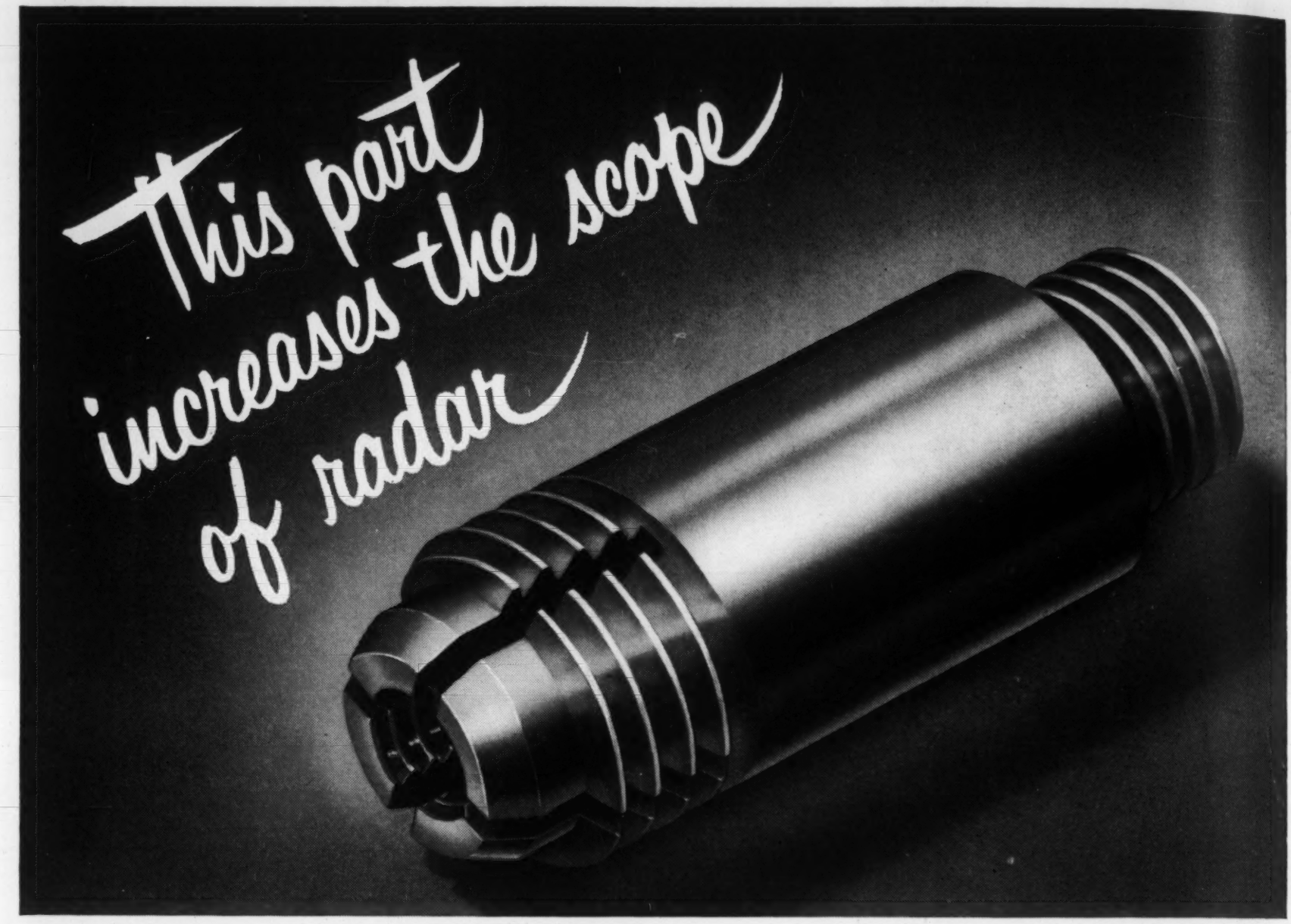

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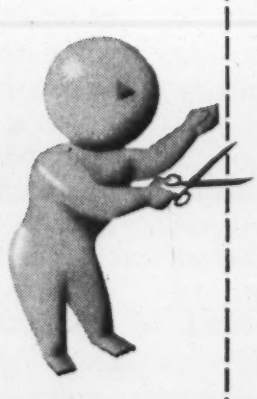

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Materials engineering is a key function in the overall manufacturing structure at Northrop Aircraft, Inc.

How Materials Engineering Works at Northrop

by **Charles M. Miller**, Materials Engineer, Northrop Aircraft, Inc.

At this aircraft plant, the materials engineering group is the hub about which the manufacturing cycle is deployed. Some of its jobs are: (1) Specifying or aiding in selection of new and/or established materials; (2) preparing specifications and standards; and (3) writing materials manual and process manual.

• MATERIALS ENGINEERING is essential to a successful manufacturing enterprise. The wise utilization of material in design and production can assist in producing high quality products in good quantity at low cost. The type of material used to make a product must be determined with thorough knowledge of the material and what it will be expected to do in service.

The many diversified types of materials and the development of so many new materials during the last decades has created another type of specialist who is now being given the title of "Materials Engineer". With increases in speed and operating temperatures of aircraft has come the need for new materials, only some of which have been supplied by pure and applied research. Here research must work in reverse; a research of the potentialities and a more close scrutinization of the limitations of the material is required before a design can be completed. The design, many times, must be altered to make allowances for the shortcomings of the material.

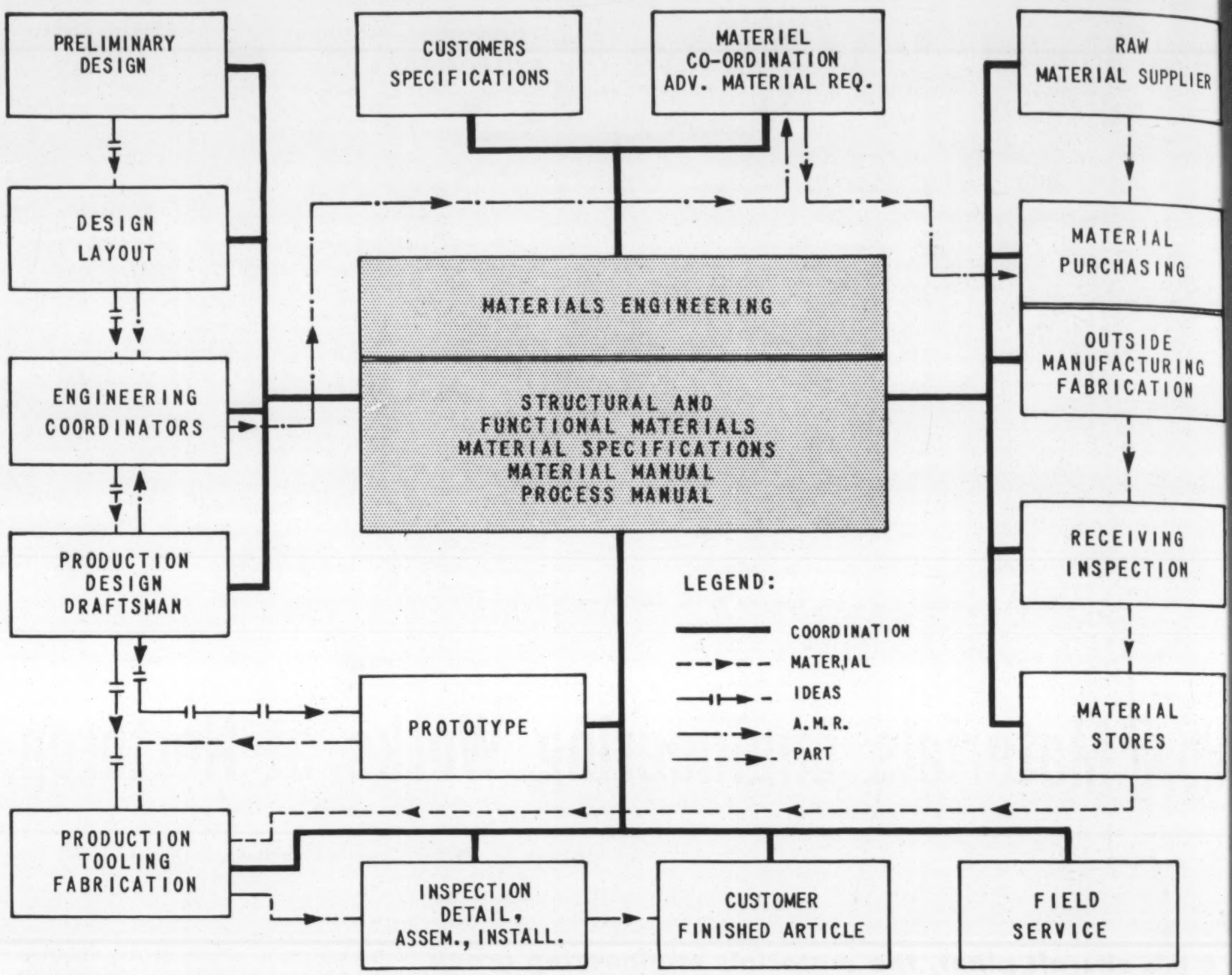
What Is a Materials Engineer?

Since materials have become so important, what is the position called materials engineer? The title may include any or all of several aspects of materials engineering, depending upon the organization of the company. In some companies this group is in the manufacturing division, while in others it may be in quality control or as a staff group to top management. Most of the materials engineering groups in the aircraft industry are in the engineering division, closely allied to the processing group, the standards group, or the test or research group. In some companies all of these functions are not put together into one department.

The most common situation is where materials and process engineers are together in a single department. This arrangement prevails at Northrop, and has several distinct advantages. The entire process laboratory, which includes chemical, metallurgical, physical test, plastic and prototype development laboratories becomes the "laboratory" for the materials group, and in the other direction, technical knowledge of the materials engineers is immediately available to these other groups.

Materials Engineering a Key Function

Since everything that we can see or feel is made out of something, it is a wonder that materials engineering is such a young profession. Actually, it is one of the oldest. The



The materials engineers are associated with materials from the drawing board through the production cycle to the installation and service life of the product. Solid lines indicate direct lines of contact. Broken lines show flow of ideas and materials which are wedded in production to become parts and products.

sword makers of Damascus were specialists in metallurgy, and the tribe with the best swords was the leader. In large plants, until fairly recently, however, as in Damascus, the individual designer, the inspector, the shop foreman and everyone else connected with the design and production of parts has been his own materials engineer. The designer has carried most of this load.

With the increased specialization that our civilization has undergone and is still undergoing, new sciences have appeared, as have new professions. The complexity of aircraft design and manufacture has progressed to the point where the designer cannot keep abreast of all the developments. He must concentrate more on his design, and in the case of materials, a new group has come into being. This group is a hub about which the manufacturing cycle is deployed; or to liken it to a modern development, a telephone switchboard. Materials engineering is, therefore, a key group in the overall manufacturing structure, a nerve center with fingers on all the engineering and manufacturing processes.

The relationship of a materials engineering group to an industrial organization is shown in the accompanying chart. Direct lines of contact are indicated by solid lines. The broken lines show the flow of ideas and material which are wedded in production to become parts and products. Some of the contacts are made by specially trained technicians because of the nature of the coordinations and geographical distances that often must be travelled to achieve these coordinations.

The nucleus of this section is a small group of technicians whose training and experience are more specialized in their respective fields. These men are the heart of the profession, and are usually either chemical engineers, metallurgists or physicists, or a combination of all three. The scope of their activity is of necessity relatively restricted to individual or closely related fields, such as aluminum and magnesium or plastics and glass. A metallurgist working on the properties of alloy steel could hardly be expected to be able to expound on the effect of extreme low temperature on the flexibility of an elastomer.

From the hub of this manufacturing wheel the materials engineer is associated with the complete flow of material from the drawing through procurement, receiving inspection, stores, shop fabrication, installation and service life on the delivered article. It is interesting to watch a new material flow through the manufacturing cycle. The points of inquiry back to the group about this new

material can be predicted quite accurately.

The Role of Specifications

The major tools of the materials engineer are specifications, those condensed outlines of the requirements for materials which are the control of material quality, consistency and reproducibility, lot to lot, year in and year out. A specification is a contractual organ, and is the basis for purchase contracts between the manufacturer and his raw materials and parts suppliers. A specification is also the document to which the manufacturer points through his salesmen and says; "This is my product—it is just what you need, and the price is right!"

The importance of a specification cannot be over emphasized. Raw material producers work to basic material specifications. These, in turn, are specified on the engineering drawings of the end product manufacturer. They are used by two inspection groups, the raw material supplier's inspection, and the purchaser's receiving inspection. They are used by the manufacturer's engineers for design limit determination and part stress analysis. The ultimate customer of the product expects that what he buys is made with high quality material commensurate with the item which he is buying and in accordance with the price that he is willing to pay.

Extreme care must be taken in the preparation of specifications so that they say what is intended, and so that they are not misleading or misinterpretable. They must outline the requirements necessary to assure quality consistent with the grade of material covered and still not be so restrictive that the raw material producer cannot produce satisfactory material. A specification is worthless if no one can make material to meet it. There should be requirements to maintain consistent quality; however, needless tests or requirements of an informative, but not quality controlling, nature should be eliminated.

Here an important function of materials engineering is illustrated. The specification is an outline of the minimum requirements to maintain quality. Where, then, does the designer, stress analyst, fabrication specialist or anyone else interested, get the design data? The materials engineer is in a position to collect, digest and distribute this information. At Northrop we maintain a two-volume manual on metallic and nonmetallic materials. The Material Manual is the source book of material data for all divisions of engineering, purchasing, inspection and manufacturing. These manuals are to be found throughout the entire manufacturing plant, a ready source of information.

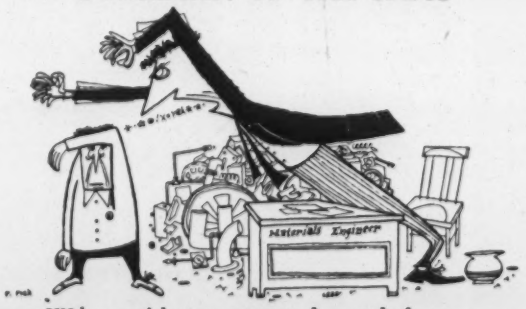
The manual serves several additional functions as well as being a general information center. Varieties of shapes and sizes are kept to a minimum through the listing of only standard or stock sizes. This keeps the engineers from specifying small quantities of many variations of materials and aids overall production by reducing the number of variables that must be handled. A further restriction is that all materials that may be read about in magazines are not available for use without a special investigation. Only the more basic, or common denominator materials, are available for design use without specific approval. Unusual, expensive or strategic materials require investigation into the need for their use. Should the need be justified, special approval can be granted. This prevents new relatively untried materials from being used beyond their limitations; it also prevents the use of "gold where lead will do".

In selecting materials for parts, direct assistance and recommendations are given by the materials engineers, not only to the engineers and detail designer, but also to the boys behind locked doors in preliminary design. The basic material parameters are often laid down by this group along with the basic design data.

Adopting a New Material

The introduction of a new material involves far more than putting it on the drawing, buying it and giving it to the shop to work into parts. Before any material can be specified on the drawing, design, fabrication, processing and finishing information must be developed as

GUARDIAN OF THE SPECS



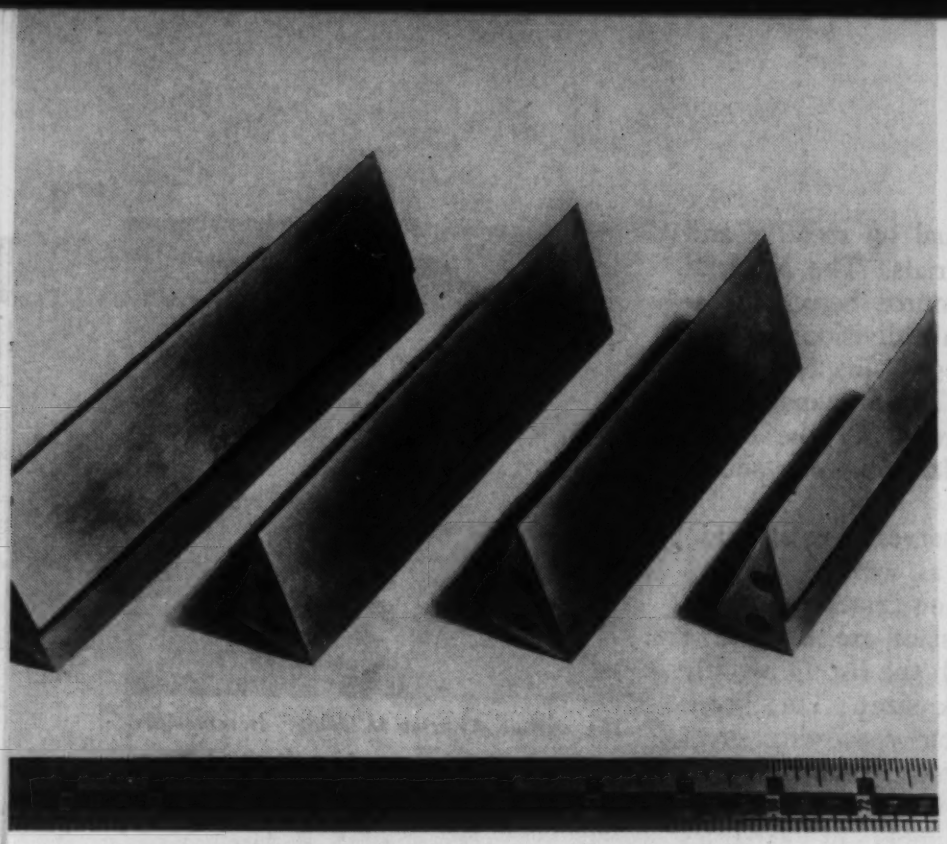
Who said para-propyl methylene—
The Spec isn't out yet!

The author, Charles M. Miller, is materials engineer at Northrop Aircraft, Inc., Hawthorne, Calif.

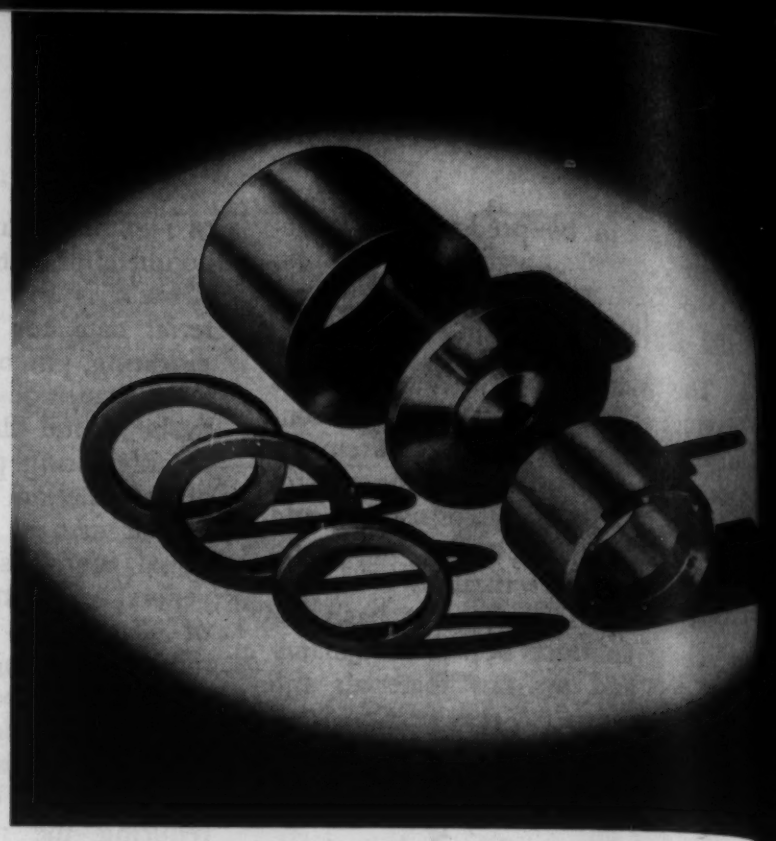
well as predicted service life data. Sometimes several years of investigation and laboratory work have preceded the release of a new material for design and fabrication. Sometimes, however, the time span is so short that the shop learns how to fabricate parts while making the first production runs. This latter case is costly, especially since the designers do not know what the shop can do when they establish the dimensions and shapes. Re-design is often a common practice in this type of development. This situation can hardly be called "production"; it is the old "cut and try" method, which gives everyone grey hair.

When all the essential data are accumulated, digested and ready to be used for direct application, the materials engineer must wait for a suitable part to introduce this material. Then, after the drawing has been issued, close follow-up must be executed to assure that the proper handling and fabrication methods are used. Many good materials have been hampered in taking hold and have actually been retarded by the way that they were introduced to the shop. The converse is also true; a material can be over-sold, which can do as much damage to the future use of that material as an underselling job.

Correct basic data is the sound foundation upon which materials engineering is based, and this data must be presented in such a manner that it cannot be misinterpreted. Investigation, education and specification are the three by-words, which are applied constantly. Coupled with these factors goes the vitally important item cost, and then seasoned well with good old common sense, this stew called manufacturing is ready to serve.



AIRCRAFT COUNTERWEIGHTS for balancing wing flaps are made of high density alloys.



DIRECTIONAL NAVIGATION INSTRUMENTS contain heavy metal components to provide high moments of inertia.

High-Density Alloys

by **KENNETH ROSE**, Mid-Western Editor, Materials and Methods

In spite of the increasing demand for lighter and lighter materials, there are still many parts in which high weight per unit volume is a must. Here tungsten alloys with small amounts of nickel and copper, fabricated by powder metallurgy methods, are finding successful application.

● WHEN HIGH WEIGHT is a requirement in a part, the engineer's choice of possible methods of obtaining it is rather limited. The standard solution is to "beef up" the design by using heavier sections, or doubling members. In many applications, however, the nature of the part is such that a high density material is required—one having high weight per unit volume.

The choice of materials of higher density than iron or steel is very limited. Lead is the only common low-cost metal having a specific gravity much higher than that of iron. A listing of the metals of higher density than iron points up the difficulty.

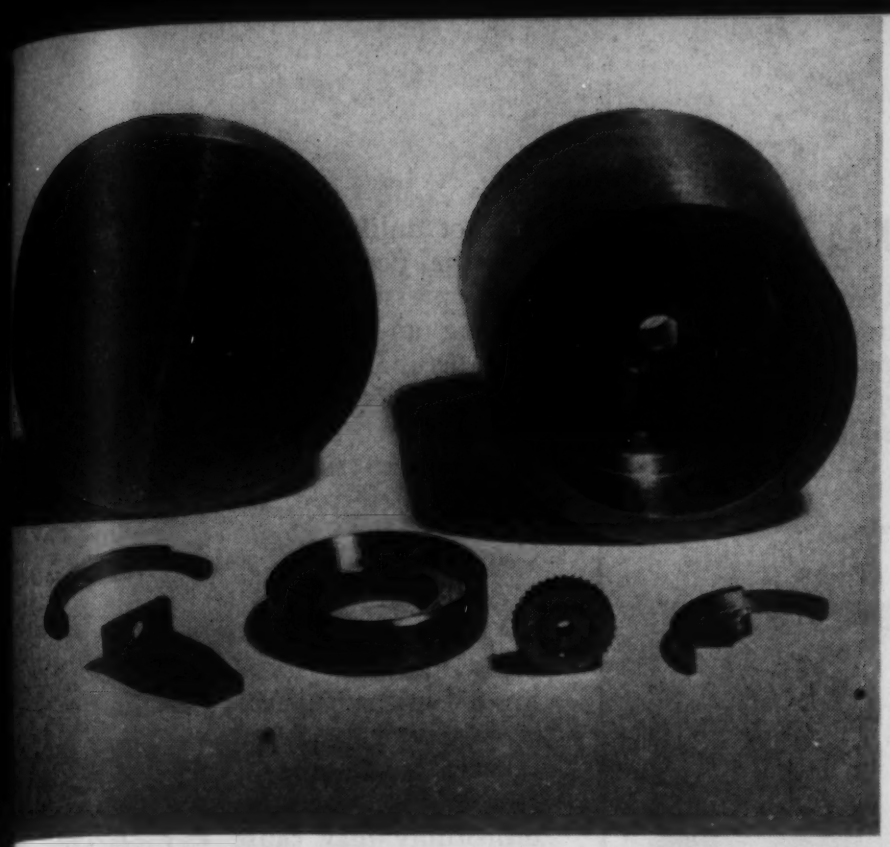
METAL	DENSITY, GM PER CU CM
Iron	7.87
Columbium	8.57
Cadmium	8.65
Nickel	8.9
Cobalt	8.90
Copper	8.94
Bismuth	9.80
Molybdenum	10.2
Silver	10.5
Lead	11.34
Hafnium	11.4
Thorium	11.5
Thallium	11.85
Palladium	12.0
Ruthenum	12.2
Rhodium	12.44
Mercury	13.55
Tantalum	16.6
Uranium	18.7
Tungsten	19.3
Gold	19.3
Rhenium	20.
Platinum	21.45
Iridium	22.4
Osmium	22.5

Of the metals of approximately one and one-half times the density of iron, only lead and mercury are in the low priced group. The low melting point of mercury rules it out for most general engineering design, so that only lead is available. The metals having densities above twice that of iron are nearly all of the gold or platinum groups, unsuitable because of high cost. Only tungsten would qualify as being of relatively moderate cost, and not being radioactive.

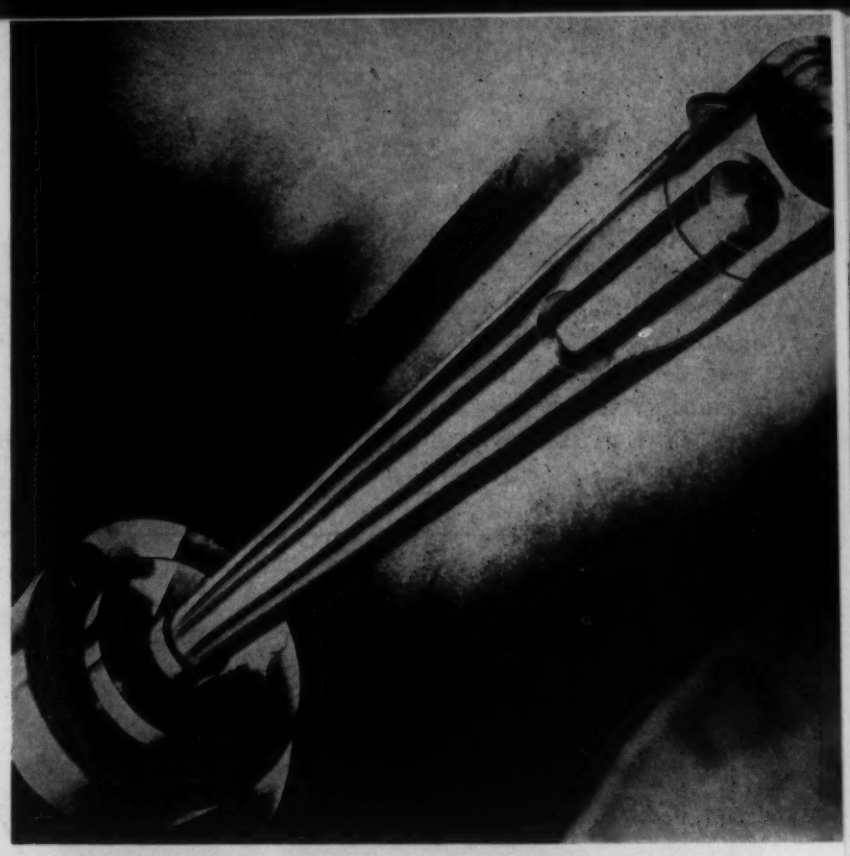
The materials engineer must pay a high price when design requirements necessitate going from lead, with a density approximately one and one-half times that of iron, to tungsten, with a density higher than twice that of the most common structural metal. In addition, pure tungsten is so difficult to fabricate that alloys formed by powder metallurgy methods are generally substituted for the pure metal.

Alloys and Properties

In spite of the significantly higher cost of tungsten, there are several standard engineering materials having high density as a special property, and using tungsten as a base. All of these standard high-density materials have similar composition, being essentially 90% tungsten, with the remainder nickel and copper. The nickel and copper serve to make the composition machinable. Use of about 6 nickel and 4% copper is most common. The material is produced by powder metallurgy methods, and so can be formed closely to finished dimensions. It has



ROTATIONAL CONTROL PARTS are a common use of the heavy alloys. The semi-circular segments shown are used in self-winding wristwatches.



VIBRATION-DAMPING EFFECT of the high density alloy inside boring bar eliminates chatter.

for Heavy-Weight Applications

the considerable advantage over the heavier pure tungsten powder in that it is machinable, whereas the tungsten or tungsten carbide can be given only a very limited additional forming by grinding, or by cutting with diamond tools.

As the high-density material is produced by pressing and sintering the mixed metal powders, its density and its mechanical strength can be varied by pressing and sintering procedure. Density of the finished material is about 17 gm per cu cm, and tensile strength will be of the order of 110,000 psi.

Materials of this type commercially available are Mallory 1000 Metal, produced by P. R. Mallory and Co., Inc., Indianapolis; Hevimet Alloy, a product of the Carboloy Dept. of General Electric Co., Detroit; Fansteel 77 Metal, made by Fansteel Metallurgical Corp., North Chicago; and Densalloy, produced by Welded Carbide Tool Co. Other producers of cemented carbide pieces or of powder metallurgy products have prepared high-density sintered compacts of this same type also. Cost is of the order of $15 to $25 per lb.

RADIOACTIVE MATERIALS are safely held in this container made of a high density alloy.

Density of the parts, and strength of the finished piece, will vary with the size of the piece, the exact analysis used, and the procedure used in compacting and sintering. Results reported by a leading manufacturer are given in the table.

Strength may range from about 85,000 psi to about 120,000 psi, with the lower strengths in the larger sections. Elongation, as percent in 2 in.,

Variation of Density with Weight of Part

Weight of Part, Gm	Average Density, Gm per Cu Cm
1 to 50	16.93
51 to 100	16.92
101 to 250	16.91
251 to 500	16.89
501 to 1000	16.87
1001 to 2500	16.82
2501 to 5000	16.73

is 2 to 10%.

The alloys have excellent resistance to chemical corrosion. Pieces of the sintered compact will have a hardness of 20 to 40 Rockwell C. Electrical conductivity is low, being of the order of 14% of that of standard copper.

Fabrication of High Density Parts

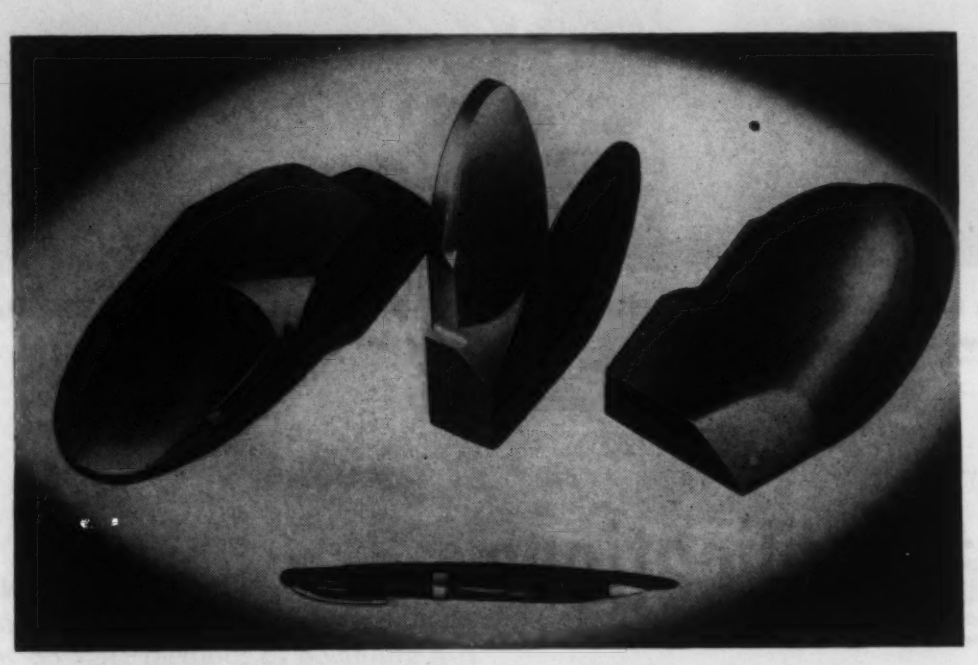
As mentioned earlier, powder metallurgy techniques are used in the production of parts made of these high density alloys. The problems encountered in the fabrication of parts are not unlike those found throughout the powdered metals industry. Cold pressing is performed, using tooling and equipment common to the method. Automatic mechanical high-production presses are used as well as slow, high-tonnage hydraulic presses. Sintering is accomplished in large, batch-type electric furnaces using cracked-ammonia gas. Shrinkage of the pressed compacts is quite high, comparable to the carbides.

Of major importance, as in all pressed powder fabrication, is the factor of uniform density. By uniform pressed density, it is meant that the density is as uniform as can be obtained by standard practices. Lack of uniformity may cause (1) cracking of the pressed compact before sintering or during sintering, (2) distortion as a result of varying shrinkage, (3) nonhomogeneity and (4) variable shrinkage resulting in scrap or excessive piece-to-piece variation. Perhaps the most nearly uniform compacting is obtained by using equal top and bottom pressure. The use of a single moving punch (top pressure only) is common in hydraulic pressing, and the result is a compact with highest density nearest the moving punch. Although the part is not uniformly compacted, the variation does not generally cause great difficulty if the piece is of uniform thickness.

As the shape of the finished part becomes more complex, the pressed density problems increase and methods other than the conventional ones are required. One such method is the use of multiple tools and/or pressing motions to produce steps, counterbores, flanges and other simple additions to the body of cylindrical or rectangular parts. This is a technique in general use throughout the industry. Presses are built incorporating multiple top and bottom motions providing for core rods.

Another method is hot pressing, which as yet is not extensively used. Besides these there are several other special methods which involve the use of some novel procedures and inventions. These include isostatic pressing, multiple pressing, and the new contour pressing method. The contour pressing method is discussed in the accompanying box.

Good machinability is one of the important advantages of the dense alloys. They are sometimes referred to as machinable tungsten. The tungsten provides the high density that is their special characteristic, and the nickel and copper provide only machinabil-



Some of the unusual shapes that can be produced by the contour pressing method.

New Powder Metallurgy Method for Producing Heavy Metal Parts

A new method of producing parts of high density alloys has been developed by P. R. Mallory & Co., Inc. Known as contour pressing, it can be used to produce uniform density parts of unusual and non-symmetrical shapes which vary greatly in section thickness, measured in the direction of pressing. The process involves some novel procedures which as yet have not been disclosed.

According to the developers of the process, contour pressing eliminates cracking. Cracking of the green compact is a definite indication that nonuniformity of pressed density may exist, and, if this be the reason for the crack, better pressing is the only answer.

Distortion, too, is said to be eliminated. Distortion is created by variation in shrinkage within the compact or in sintering because of variable density. Distortion is quite apparent on nonuniform parts if shrinkage of the metal is appreciable. Accurate estimation of shrinkage is a must in establishing final size of the part.

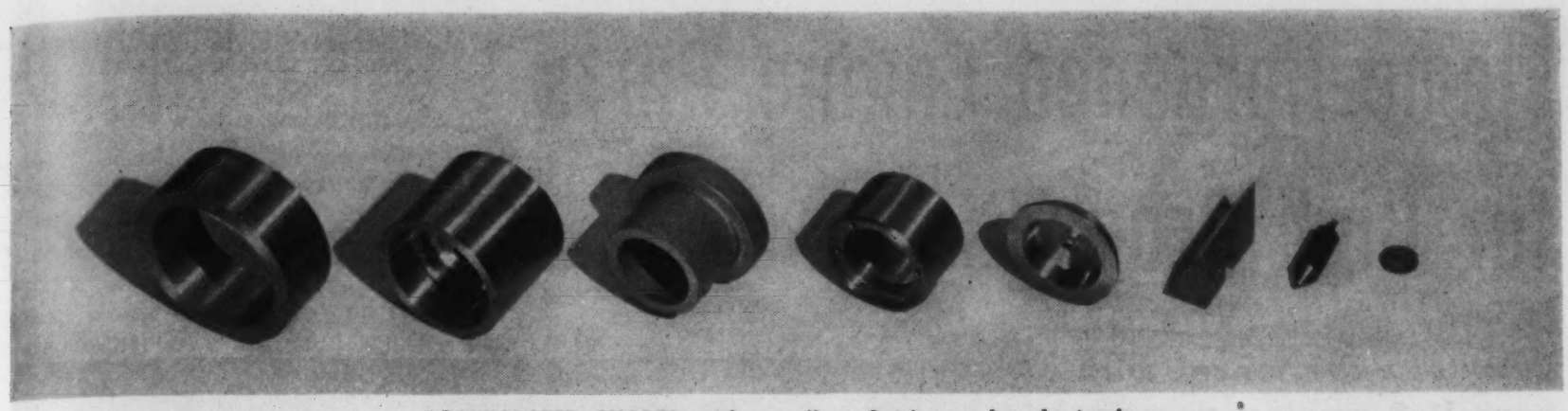
Tools can be designed and made which will produce the final size and shape of the desired part. Previously, the only way of making tools for a part with a variable shrinkage was by the trial and error method, which is time consuming and quite expensive.

Production of a part to finished size often eliminates, and certainly reduces, costly machining operations. Machining parts of a complicated nature may mean the use of contouring or special milling cutters, which are expensive. Part-to-part variation can be held to a minimum if certain practices of controlling apparent density of the powder and uniform filling of the die cavity are followed. The part-to-part variation then becomes only the process variation and, if maintained at a minimum, the part produced will hold standard powdered metal tolerances.

Certain limitations exist in the contour pressing process, however, but they are said to be no more restrictive than those encountered in other powdered metal methods. For instance: tooling is expensive, necessitating large production runs. Production rate is relatively slow because of the usual complexity of parts produced and the use of slow, high-tonnage presses.

At present, the principal field of application is in counter-weights wherein the part is made to fit available space. Other possible applications are those in which a radius of curvature exists. This kind of part presents the variable section thickness problem.

The use of the contour pressing method makes possible the production of parts by powder metallurgy which have been previously impossible, or at least, considerably more difficult to produce. The result, of course, is to broaden the field and increase the use of powdered metals.



COMPLICATED SHAPES *with excellent finish can be obtained.*

ity. They can be finished by turning, milling and shaping, drilling and tapping, using cemented carbide tools and cutting speeds about the same as for cast iron. Grinding can be accomplished with a medium hardness vitrified bond wheel, preferably of aluminum oxide abrasive.

The materials can be copper brazed or silver brazed. Copper brazing is done at about 2000 F, in a reducing atmosphere, and without flux. Silver brazing is not difficut if the alloy has first been tinned with copper, at about 2000 F in a reducing atmosphere, and a silver alloy melting at about 1425 F is used. A satisfactory bond can also be obtained without coppering. A reducing atmosphere is recommended for silver brazing also. Hydrogen welding can be used successfully to join the alloys, and ordinary soft soldering is sometimes used. Mechanical joining, using threaded fasteners, is the preferred joining method, however.

Uses

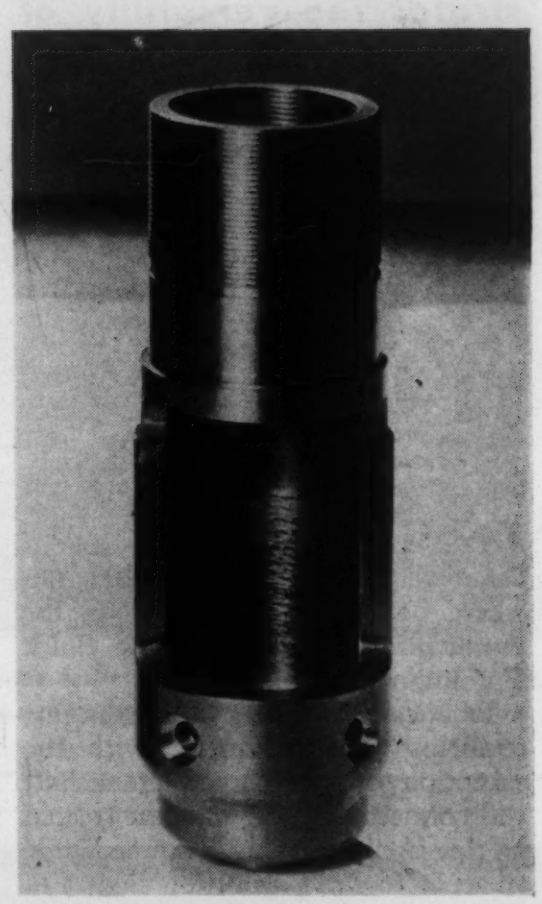
Uses of the high-density materials are associated with its weight as such, or with the shielding against radioactivity that goes with their high density. They might be grouped as follows:

Static and dynamic balancing—Applications include such varied parts as the tiny eccentric weight used in self-winding wrist watches to actuate the winding mechanism, counterweights used in military aircraft for balancing the wing flaps and other control surfaces, for counterbalancing and stabilizing aerial cameras and radar antennae in planes, and for dynamic balancing of flywheels. For some of these applications only a combination of high density with minimum volume is required, as in counterbalancing of such stationary or slow-moving parts as aircraft wing flaps or wristwatch winding weights. In others, mechanical strength is an additional requirement, as in balancing of fast-turning flywheels.

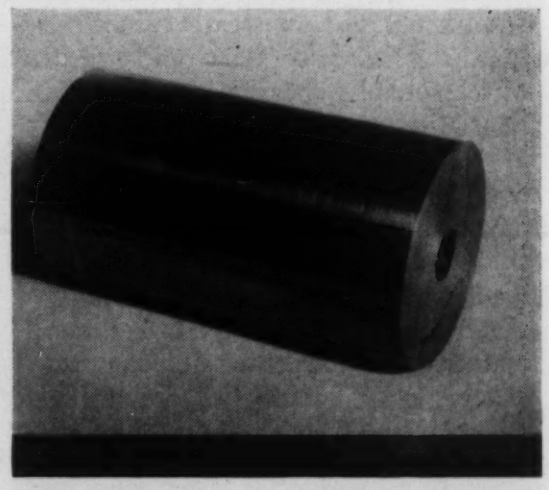
Rotating inertia members — Such pieces include flywheels, gyroscope rotors for positioning of navigational instruments, and rotating members on governors. Flywheels can be made entirely of the high-density alloy, or they can be made with a rim of the material. For all of these applications good mechanical strength is required along with high density.

Vibration damping members — Bands or other members of boring tools tend to reduce vibration in the tool bar that might lead to chattering. It is reported that tool breakage is lessened also.

Radioactive shielding—For shielding against gamma-rays and hard x-rays where absorption is generally proportional to the density of the absorbing material, high-density materials of the type described are about one and one-half times as effective as lead, the most widely used metal for shielding. This additional shielding effect becomes of importance when the cone, bomb or capsule in which radioactive material is being used or transported must be of small size. It is especially desirable in medical work with radioactive material. In the radioactive logging of oil wells, a capsule containing the radium or other radioactive material is lowered into the well casing, making small space of the package a requirement. The greatly increased use of radioactive isotopes in industry for tracers, wear tests, and the like is making this property of high radioactive shielding of interest. The high density materials here discussed are not suitable for shielding of primary atomic fission byproducts that emit neutrons, because of transmutation by-products resulting from neutron bombardment. P. R. Mallory & Co., however, reports that its alloy, under low intensity neutron bombardment, average intensity alpha radiation, will produce extremely low millicurie intensity transmutation products.



COUNTERWEIGHTS *such as this often require good mechanical strength as well as high density.*



CONTAINERS FOR RADIOACTIVE MATERIALS *are an important use of high density alloys. This one is used to hold the radioactive source during logging of oil wells.*

PICTURE CREDITS: *Carboloy Dept., General Electric Co.; Fansteel Metallurgical Corp.; P. R. Mallory & Co., Inc.*

Flame-Hardened Engine Parts for High Production

by HERBERT CHASE

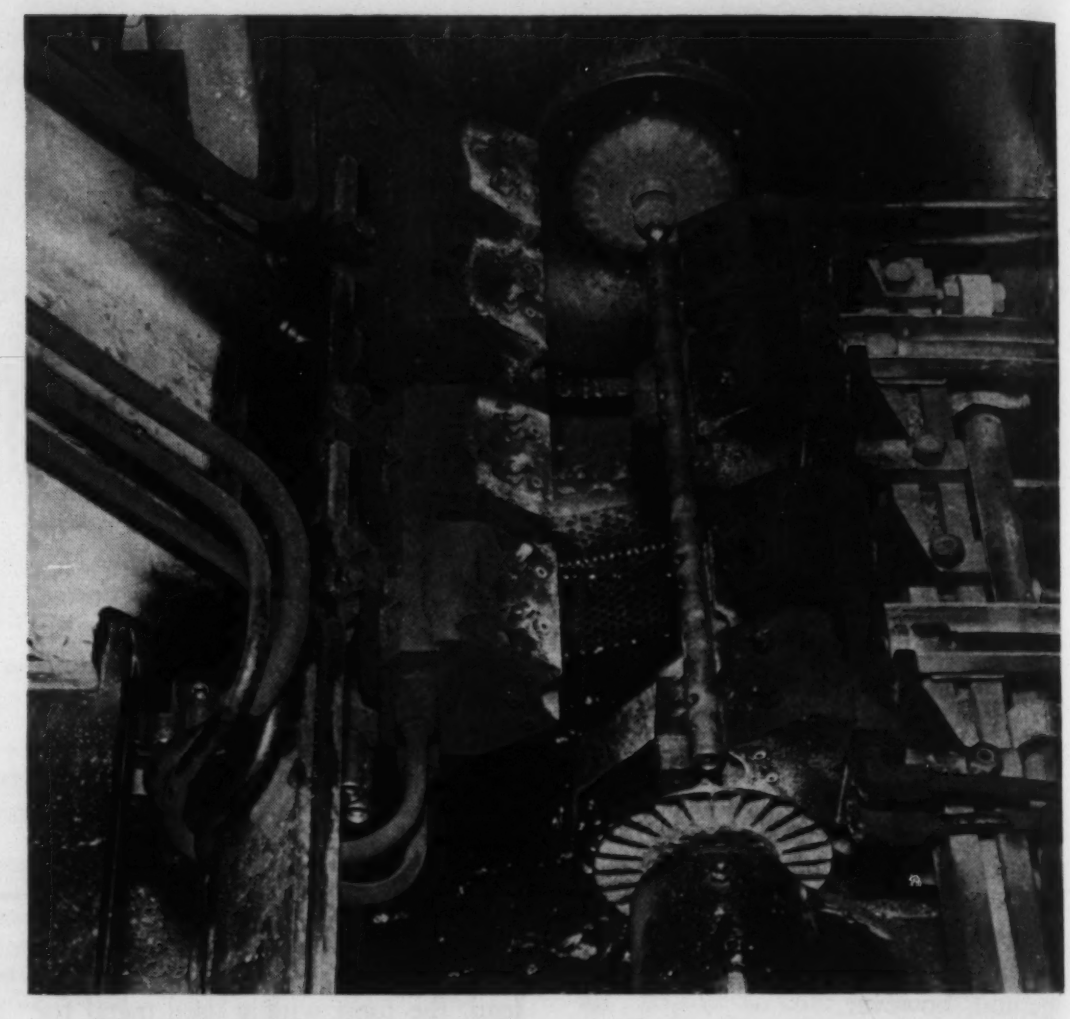
Buick's experience with new V-8 engine demonstrates the versatility of selective surface hardening used on steel and malleable iron parts.

● THE INHERENT ADVANTAGES of flame hardening are probably nowhere better illustrated than in the production line for the new Buick V-8 engine at Flint, Mich.

Practically all parts of this engine requiring heat treatment, with the exception of the forged crankshaft and connecting rods, are heat treated in the machining areas immediately adjacent to the production line, and without the smoke and dirt commonly associated with this phase of production. As a result, materials handling problems are greatly reduced. Transfer of large quantities of parts to and from separate heat treating rooms or buildings is unnecessary, and the size of part banks in process at a given time is correspondingly decreased.

All flame heating is done with propane or mixtures of propane and oxygen in Cincinnati Flamatic machines designed especially for high-speed handling of these particular engine parts. Magazine feeds, radiation temperature sensitive elements and electronic cut-off devices are utilized wherever possible to afford the maximum possible degree of automatic operation.

The typical flame hardening operations shown and described briefly on these pages are eloquent proof of the extent to which the heat treating function can be integrated into a high production line by means of flame hardening.



BEARING SURFACES of this SAE 1008 hollow rocker shaft are carburized to a depth of 0.030 to 0.045 in.

Hollow Rocker Shafts

Eight different areas of this flute-like part are selectively hardened to provide bearing surfaces for the rockers to be mounted on the shaft. Since the material used is SAE 1008 steel, the gas mixture must be adjusted to provide a carburizing flame. A carburized case depth of 0.030 to 0.045 in. is required.

To insure uniform temperature and case depth before quenching, the shaft is automatically rotated while being heated. Each of the eight areas to be hardened has 12 gas jets playing upon it.

The quench solution consists of 250 lb soda and 50 lb sodium nitrate dissolved in 300 gal water. No tempering is required, since the uncarburized portion of the low-carbon shaft is unaffected by the quench.

The shaft is fed to heating position from a loaded magazine by means of an air operated slide. The movable set of nozzle blocks (shown to the left above) then shifts into heating position and the gas is turned on and ignited. At the same time rotating centers advance pneumatically from each end to turn the shaft. When a given surface temperature is reached, the gas shuts off, the movable nozzles retract and the shaft is released to fall into the quench tank below. A woven wire belt picks up the part at the bottom of the tank, carrying it through and out of the quench.

All these operations are fully automatic. Production rate is 150 shafts per hr.

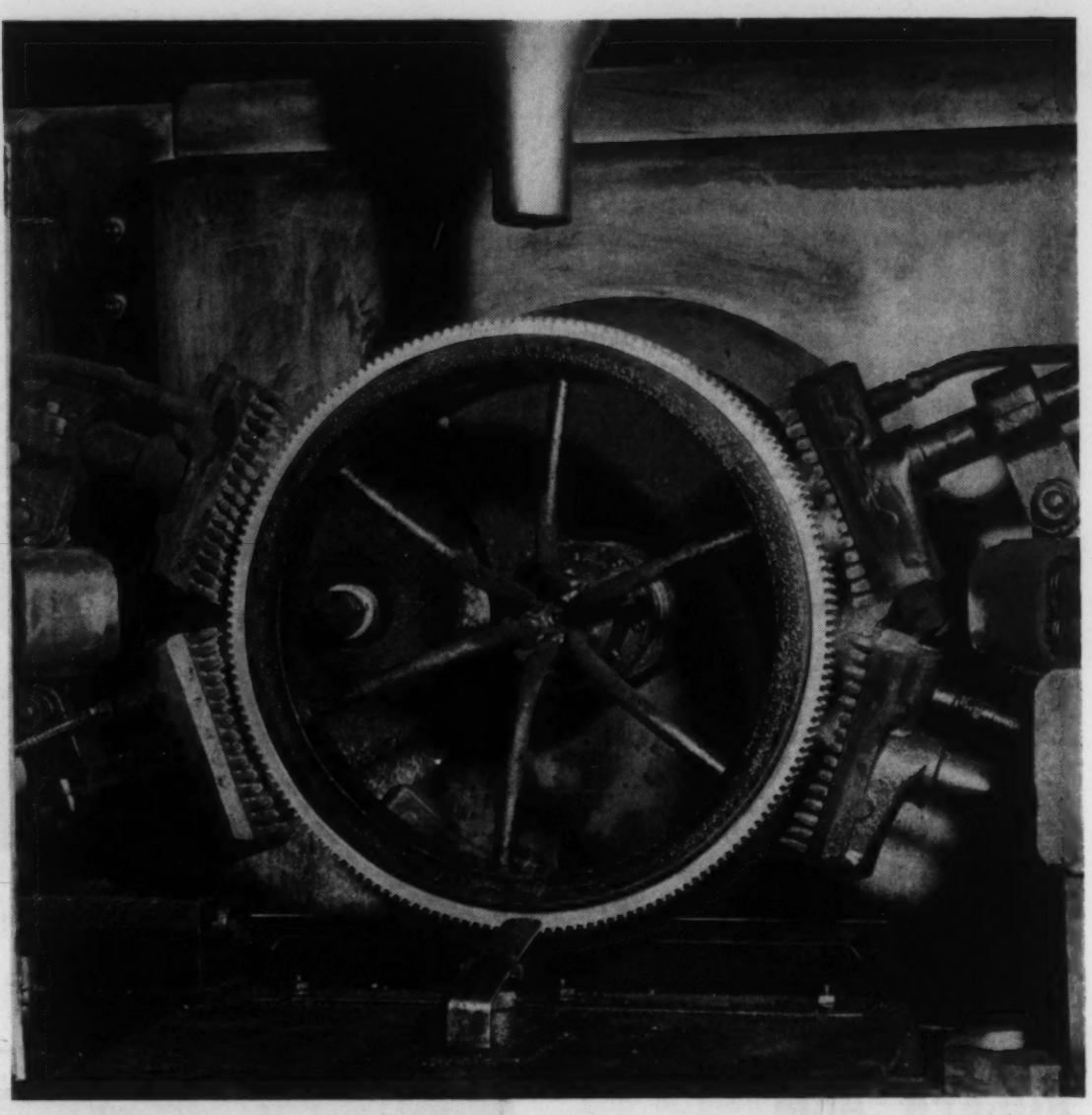
Flywheel Ring Gear

The teeth of this gear are hardened to 55 to 60 Rockwell C on the surface, but the applied heat is carefully controlled to prevent hardening of the teeth closer than 1/16 in. to the roots. Material used is SAE 1045 steel which has been rolled to form an annular ring and butt welded at the joint.

The gears are rotated two at a time in the set-up shown. They are quenched in 4C Houghton oil from a hardening temperature of 1575 F. Tooth hardness is drawn to 45 to 50 Rockwell C in the subsequent process of shrink fitting the gear to a disk.

The two gears rotate between two pairs of nozzle heads, each supplying 30 gas jets. When the hardening temperature is reached, the "eye" (shown at top of picture) causes the gears to be pushed off the wheel and dropped into the quench tank, which is momentarily uncovered. A wire belt conveys the parts through the oil bath and then through a washer for oil removal. Production rate is 300 gears per hr.

Following this heat treatment, the gear is shrink-fitted to a disk and subsequently skip-welded at this joint. A semi-automatic induction heating and sprinkling system is used in the shrink fitting operation.



***CAREFULLY CONTROLLED HEATING** hardens the teeth of these SAE 1045 fly wheel ring gears but keeps roots tough.*

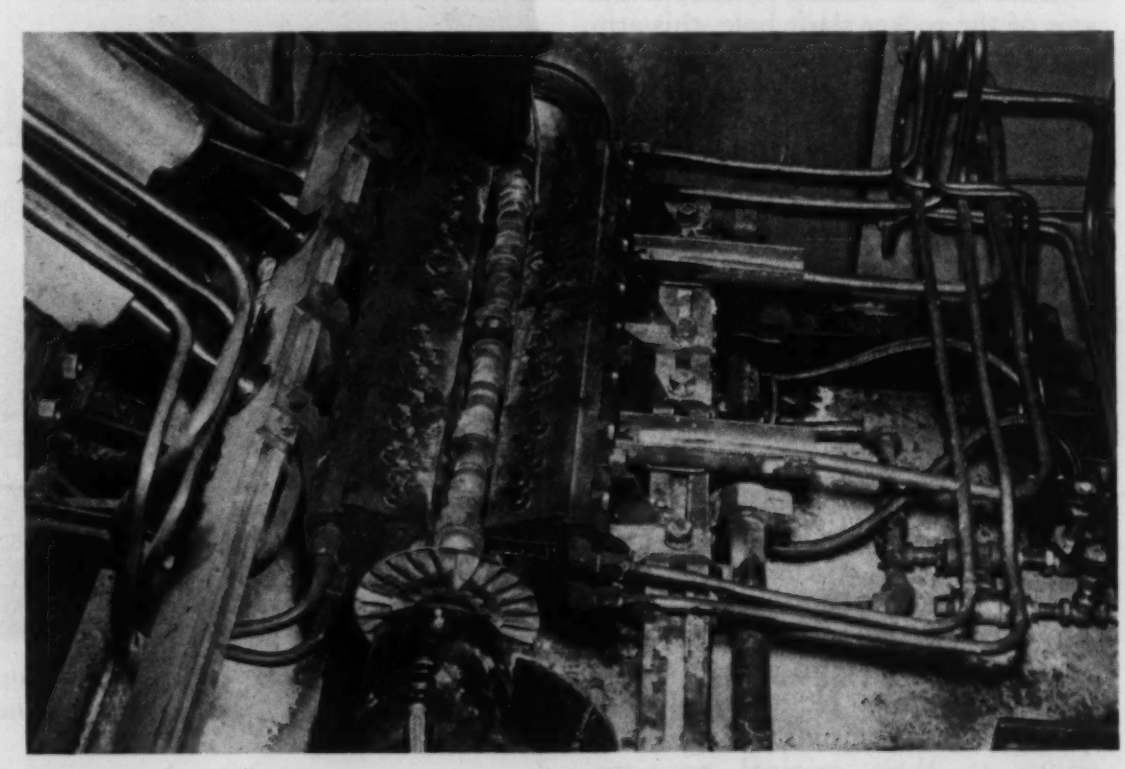
Camshaft

Selective surface hardening of the camshaft is handled in a set-up quite similar to that used for the rocker shaft. The camshaft, however, is carburized prior to the flame hardening operation so that a carburizing flame is not necessary here.

On the camshaft, the surfaces of 16 cams and of five bearing areas are heated to quenching temperature. A hardness of 56 to 62 Rockwell C is obtained on these surfaces, but these values are reduced somewhat by subsequent drawing at about 425 F.

The heating cycle required is about 24 sec, and about three additional seconds elapse before the heads withdraw and the shaft drops into the quench bath. Production rate is about 150 shafts per hr.

The camshaft is originally forged from SAE 1016 steel and carburized to a case depth of 0.070 to 0.090 in. throughout its length in a pit type furnace under a controlled atmosphere. After slow cooling, it undergoes various machining operations in which part of the case is cut away. Following the flame hardening operation, the camshaft is drawn in a vertical type furnace of Buick's own design.



***SIXTEEN CAMS** and five bearing surfaces are hardened on this forged, previously-carburized SAE 1016 camshaft.*

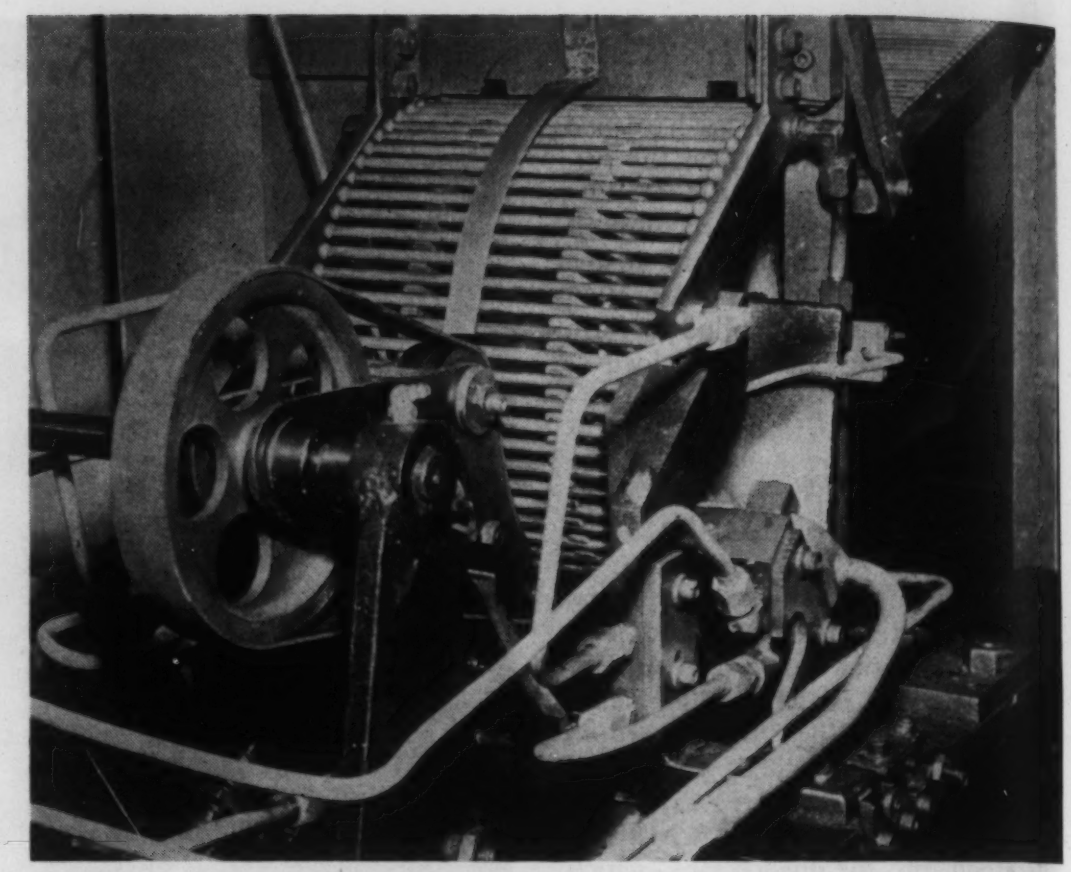
Valve Push Rods

The valve push rod is made from 9/32-in. hot drawn SAE 1062 steel wire which has been cold headed to produce an upset ball at each end. The object of flame hardening is to make the outer half of each ball surface file hard.

While these surfaces are being heated, the rod is being rotated and at the same time is moving through the flame in an arc path. As the ball surfaces reach quenching temperature, the rod clears its carrier and drops into the Houghton 4C oil bath. Hardness obtained is 60 to 62 Rockwell C and no subsequent tempering is done.

In this set-up, the rod is fed by an inclined magazine to a slowly rotating cage. The cage has gear-like end plates which pick up the rod and advance it counter-clockwise through an arc of about 200 deg. The rotating motion is imparted by means of friction contact with a driven belt as the rod is carried through the heating zones.

The quench rods drop on to a wire belt and are carried through a washer to remove the quench oil. Then each ball is ground to a true spherical radius.



***ROTATING GEARS** carry cold headed SAE 1062 valve push rods through steady flame to harden ball ends.*

ROCKER ARM

This part represents one of the earliest production applications of flame hardening to pearlitic malleable iron castings. Looking parallel to the axis of the rocker shaft hole, this arm has a somewhat crescent shaped contour. On one side is a pad and on the other side a socket into which will fit the ball end of the valve push rod. These two portions are hardened simultaneously and no tempering is required.

Semi-automatic operation is used. The operator places a rocker over each of seven pins in a set, then pushes buttons to start the gas jets and ignite them. At each pin, two jets heat the bearing surface of the pad, three heat the inside of the socket, and one the outside of the socket.

After an automatically timed heating interval, the pins retract, dropping the castings onto a shelf which tilts them into a Houghton 4C oil quench bath. The pins and the shelf return to their original positions ready for a new load. The machine has two sets of seven pins handled by one operator. Each set operates independently and the operator can load the second and start it up while heating is progressing at the first.

***INSIDE AND OUTSIDE** of socket on this malleable iron rocker arm are hardened simultaneously.*

The wire belt in the quench tank is divided into two channels. If one machine is handling both the "right" and "left" rockers, one type on each set of pins, a shelf tilt adjustment can be made to divert these parts into separate belt channels and thus avoid a subsequent separation problem.

Since each automobile engine requires 16 rockers, three machines, each handling 14 arms at a time, are needed to keep up.

Fig 1—ALUMINUM COVER for roof ventilator represents simple spinning job. Material is 350 1/8-in. thick. It is spun into dish 24 in. deep and trimmed to 93-in. dia.

Large Spun Metal Shapes

—should be considered when:

- ***Shapes cannot be easily drawn or stretched***
- ***Symmetry is needed***
- ***One-piece fabrication is desirable***
- ***Tool cost must be low***

by W. A. WENMAN, Manager, Metal Spinning Div., Phoenix Products Co.

● CONFRONTED WITH THE selection of a forming method for large metal pieces of relatively light gage, the engineer may choose drawing, stretching or spinning.

Stretch forming is rather limited as to shapes which can be made, metals which can be used and gages which can be worked. In contrast, drawing is the most widely usable method with regard to shapes which can be produced and thickness of metal which can be worked. Spinning is limited to forms symmetrical about an axis. Where this condition can be met, however, this method has certain advantages that frequently tip the scales in its favor.

Advantages of Spinning

Some of the advantages of spinning as a fabricating method are:

1. Tool cost is low. This has important corollary advantages. It makes possible the spinning of a single piece for experimental use, or as a prototype in a design. In addition, short runs for which drawing die costs would be prohibitive can sometimes be spun.

2. It permits one-piece fabrication in many cases. In work of a shape that ordinarily would require assembling from several pieces by welding or by use of fasteners, it is sometimes possible to make the part by spinning from a single blank.

3. It provides perfect axial symmetry in the formed pieces. Axial symmetry is a necessary condition for suitability for spinning, but spinning is also one of the best methods for producing axial symmetry in a piece of work.

4. It makes possible the forming of certain shapes considered not easily drawable. Conical or truncated conical forms, for example, are not regarded as practicable for drawing operations. Such forms can be spun without difficulty.

5. It may utilize the work-hardening characteristics of the material. In common with other methods of cold forming, the material may be started in the process in the annealed condition and worked to higher physical properties.

While these advantages hold true for spinning in general they are of particular importance when the workpiece concerned is of large size. Production of experimental models, for example, can be a costly matter when large dies must be made. Even for long production runs, the matter of

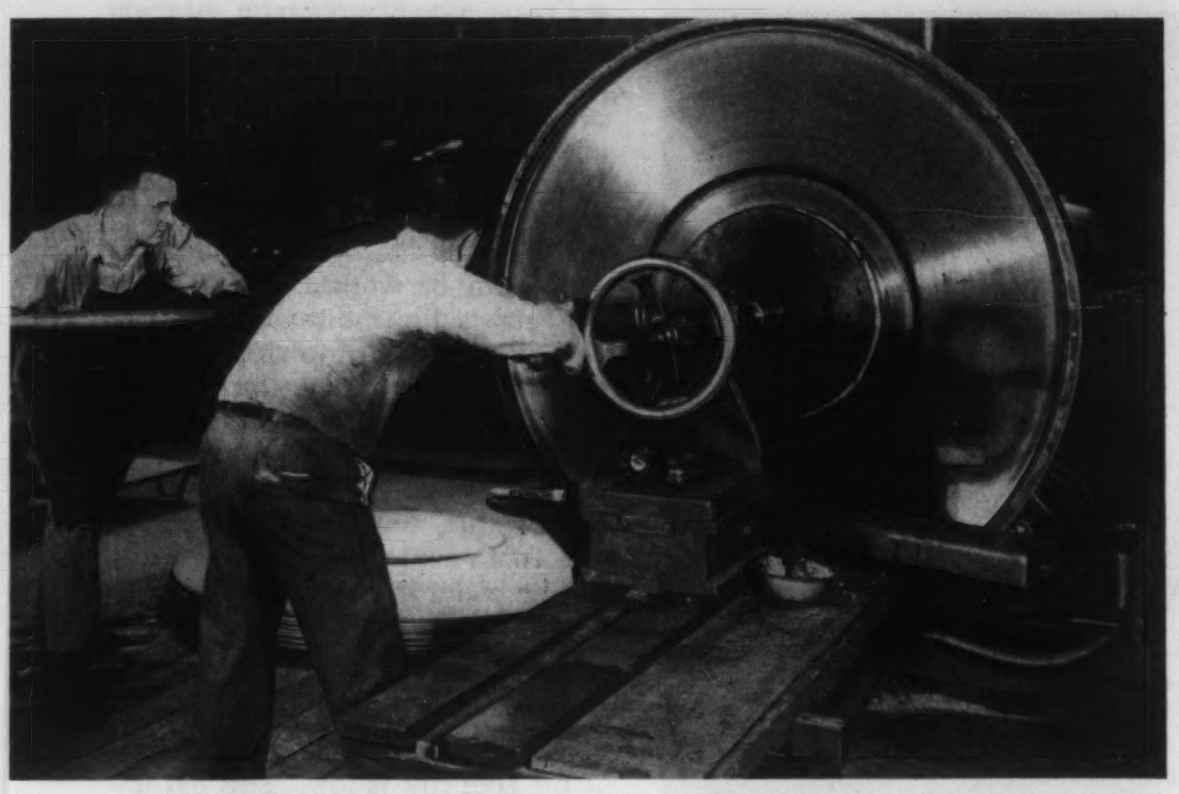


*Fig 2—**STAINLESS STEEL COVER** for pasteurizer must be polished after spinning. Material is 14-gage Type 304. It is spun to dish 8 in. deep and 64 in. in dia.*

tool costs may be so strongly in favor of spinning as against deep drawing as to decide the choice of method. Where change in design is a possibility, it should be remembered that the wooden forms used for most spinning operations can be modified much more readily than even shortrun drawing dies of kirksite, cast iron or soft steel.

Versatility

Spinning is quite versatile in the metals it can process. The alloy steels in general, most stainless steels, the copper alloys, nickel and its alloys, aluminum and its alloys, magnesium alloys, and all metals capable of cold working are spinnable, though to different degrees.

The process is also versatile in its techniques. Tooling can be varied from the simple wooden block by use of various backup rings or rolls, split rings, etc. The process can be made mechanical in special spinning machines. Hot spinning is a variation of the basic technique which is useful in forming some metals, particularly in the heavier gages. Finally, combinations of spinning with other processes widen the scope of this means of fabrication.

Tooling

Handling of large pieces of work requires that, in addition to lathes with sufficient swing, annealing furnaces and handling equipment of ample capacity must be available. The largest standard spinning lathe has a 72-in. swing, but this does not prevent going to spinnings over 100 in. in dia. Standard lathes can be modified by adding raising blocks and reinforcing. Several metal spinning companies build larger lathes to accommodate individual requirements. The matter of furnace capacity is made less difficult by the two-dimensional nature of the work, which requires only that the furnace be wide even if its cubic content be small.

Spinning is usually done against a shaped wooden block, which may be bound or faced with iron to afford longer life. The spinning tool may be of the bar type, or it may have a roll mounted at the contact end to reduce friction. While spinning tools are usually of metal, wooden tools are sometimes used, especially for light finishing operations where a good finish is required. A rotary steel cutter is most used for trimming, though a sharpened pointed tool may be chosen for operations in soft metals. Wood tools are more durable than might be thought. Several thousand pieces can be made from one set of wood tools, providing tolerances and finish are not too critical.

Applications and Techniques

Aluminum Ventilator Cover—Illustrating the spinning of large size work is the production of an aluminum cover for a roof ventilator (see Fig 1). This piece is started from a blank more than 8 ft in dia. The metal used is 3S aluminum in the annealed temper, and the stock is 1/8 in. thick. This is spun into a dish 24 in. deep, and the finished piece is trimmed to a 93-in. dia.

Stainless Steel Pasteurizer Cover—Tooling for the aluminum cover is simple, as the shape of the piece involves no complications in forming the metal. A piece somewhat more demanding in its requirements is a stainless steel cover for a pasteurizer (Fig 2). As with all dairy equipment, a smooth finish is necessary.

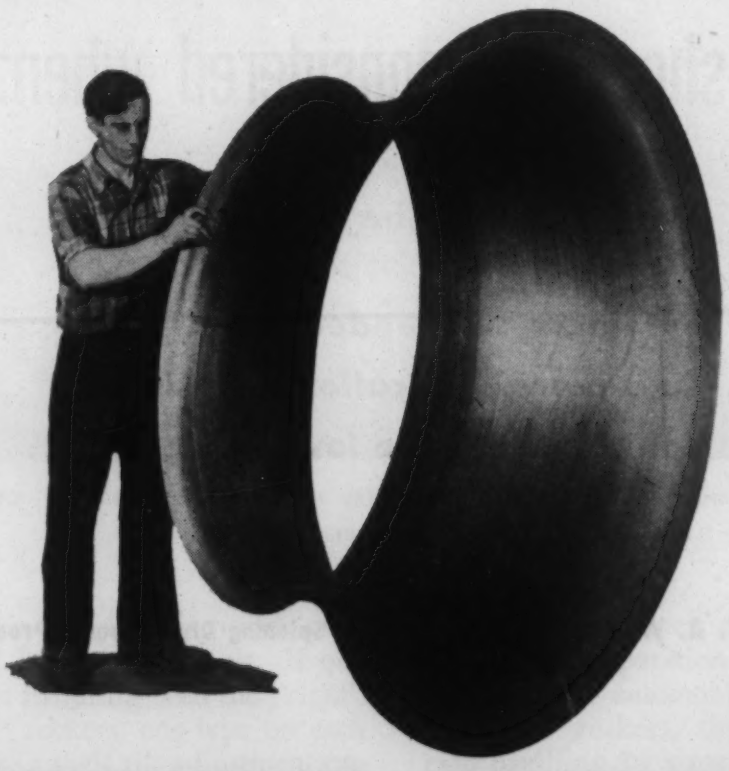


*FIG 3—**LOW-CARBON STEEL INLET CONE** for ventilating fan was spun from a welded truncated cone. The 14-gage piece is 24 in. deep and has a large diameter of 72 in.*

This piece is 64 in. in dia, and is spun to a dish about 8 in. deep. All contours must be smooth. The metal used is Type 304 stainless steel in 14-gage thickness. Obtaining a No. 4 Dairy Finish requires polishing after the spinning operation by means of a portable belt grinder and polishing wheels.

The work is begun by turning the flange on the outside over a male block. This holds the dimension and prevents waviness in the edge. The piece is then dished into a concave block, working from the outer edge toward the center. A shallow dished piece is usually formed from the outside in, while a deep draw will ordinarily be made from the inside out.

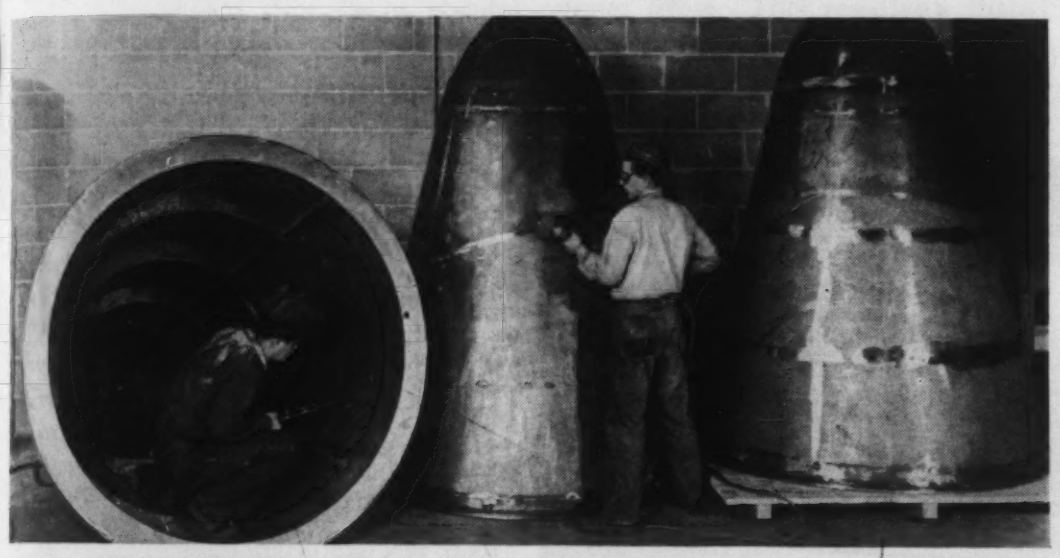


Fig 4—COMPOSITE FABRICATION is illustrated by this valve part. Material is Type 316 stainless with mild stiffening members. Nose was spun and then welded to 16-gage conical body which had been formed by welding together two large sheets.

Aluminum Aircraft Part—An aircraft part spun of aluminum alloy must be spun to close tolerances for contour, and good strength is also required. The piece is made of 24S alloy in 0.032-in. thickness. As a preliminary to spinning, a flat disk is blanked from the sheet stock and the blank is given a solution heat treatment. This consists of heating at 910 F for about 10 min, then immediately immersing in cold water. The pieces are then held in dry ice until ready to spin. They will age to the T4 condition within about 24 hr after the temperature is permitted to rise to room level.

The shape of the piece is such that special tooling must be used. The work begins by spinning the flat disk from the center to the first break in the curved contour, and continues after this break by spinning the second curve from the break to the edge of the piece. The edge is then spun back upon itself in a reverse forming operation. This is accomplished by positioning a backup roll in front of the surface as spun against the block, and near the edge of the work supporting this roll from the bed of the lathe. In smaller work, or where desirable for any reason, the backup roll might be supported from the tailstock of the lathe. The edge of the work is then spun away from the block and against the backup roll.

Truncated Sphere—The same general plan is followed in spinning a piece having a form approximating a truncated sphere. For one of these it was required to spin a shell having about 240° of the spherical form. The piece was begun as a disk, and spun over a male block to a form approximating that of a cylinder with spherical bottom. A formed roller, supported from the tailstock, was then moved in and the sides of the cylinder were spun inward against the roller to obtain the spherical form.

Inconel Pear Shape — When the inside flange must be spun on the edge of an unsupported piece, a split ring may be placed inside the edge, with a cage to hold it until ready for removal. The flange may then be turned against the ring, and when the work has been completed the ring is removed in sections from the inside position.

A piece of this sort was spun for the U. S. Air Force in Inconel about 0.078 in. thick. It had a form approximately pear-shaped, with the largest diameter about 24 in. This piece was begun as a truncated cone rather than as a disk, and both ends of the cone were spun inward.

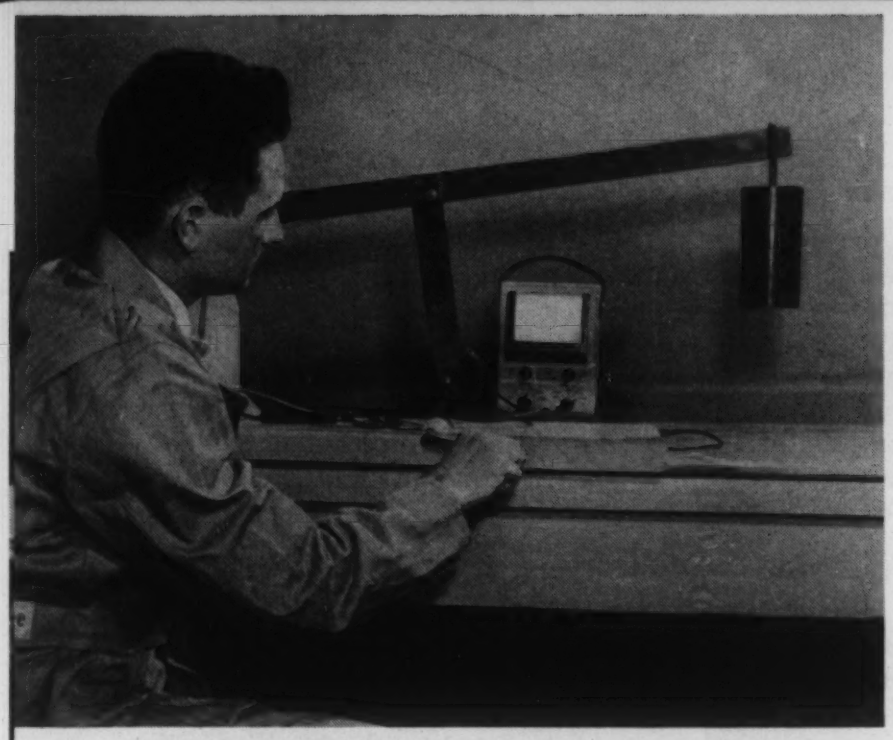
Steel Inlet Cone — The truncated cone was used as the starting point for another piece made in low carbon steel of 14-gage thickness. This piece was to be an inlet bell for a ventilating fan (Fig 3). Sheet stock was cut and formed into the truncated cone by welding and grinding the welds smooth. The cone had a large diameter of 72 in. and was 24 in. deep. The slant height was spun to contour, and flares were spun outward at both ends to complete the piece.

In the spinning of these conical pieces, the amount of angle and depth are the important factors in determining whether the piece shall be started as a flat disk or as a welded conical blank. Spinnings of a conical form approaching flatness can usually be made from a flat disk most advantageously, whereas those pieces of pronounced conical form are frequently simplified by starting with a welded conical blank.

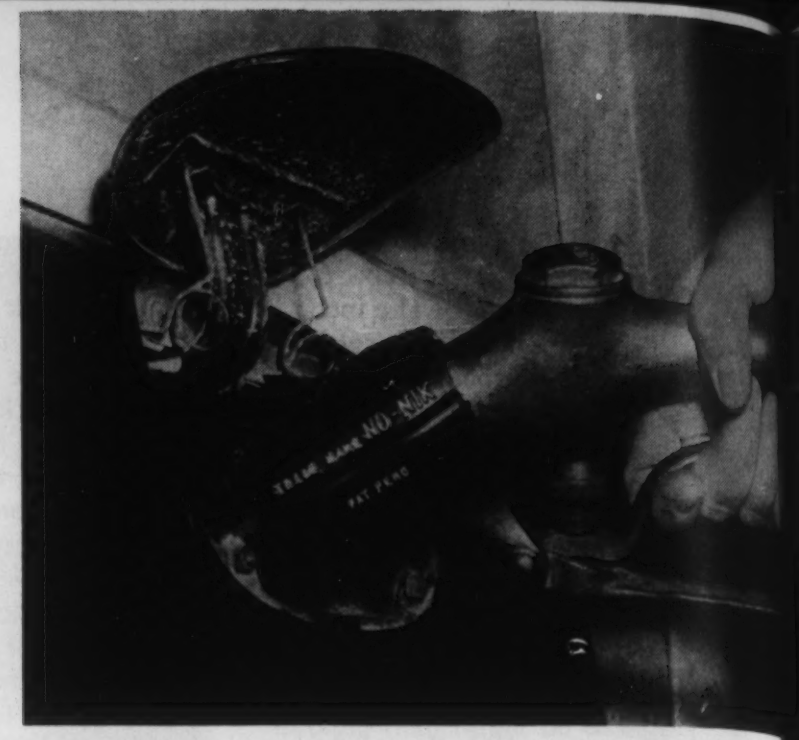
Stainless Steel Composite Fabrication—Just as castings and wrought forms may frequently be welded into an assembled piece with a lowering of costs over those of one-piece fabrication, so spinnings may sometimes be joined to sheet metal parts to produce a piece at lower cost than could be obtained by unit fabrication. An example of this composite fabrication is found in a valve part for an aircraft testing laboratory (Fig 4). The large conical structure is of 16-gage stainless steel, Type 316, with mild steel stiffening members inside. The conical body was formed by welding together longitudinally two large sheets of stainless steel, and then welded the circumferential and longitudinal stiffeners to the inside surface. The nose section was spun from stainless steel of the same type, and this spinning was welded to the conical body to form the piece. Welds were ground flush.

Hot Spinning

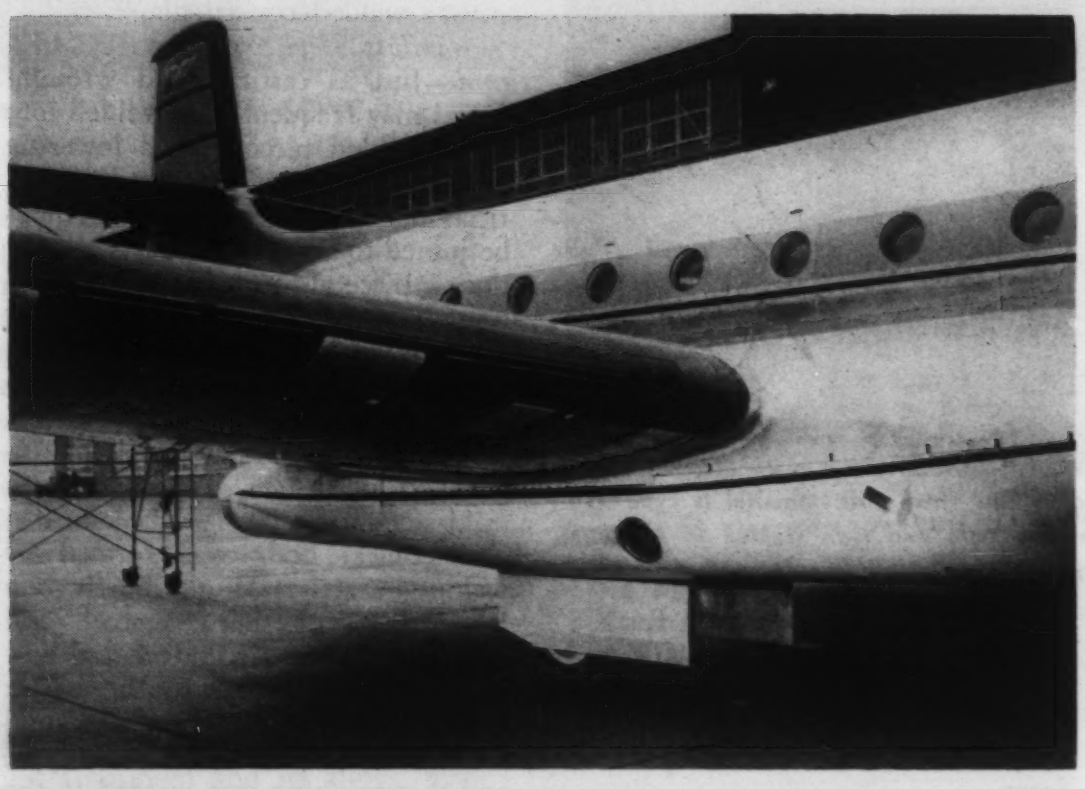
While spinning is a cold forming method, the same process can sometimes be used with heated metals. Hot spinning is largely limited to experimental work, as most pieces in production runs would be hot pressed. Hot spinning may save tool costs during the experimental work upon a design. It is most useful in the forming of steels in relatively thick sections, which could not be easily formed unless softened by heating. Pieces in 4130 steel, in thicknesses of from 16-gage to $\frac{3}{8}$ in., have been formed into dished heads of about 18 in. in dia, using steel tools, with multiple tip torches to heat the work while spinning.



CASTER WHEELS *used on hospital equipment prevent electrostatic sparks that might ignite anesthetic gases.*



GASOLINE HOSE PUMP NOZZLE GUARD *is made of conductive neoprene to protect car finishes and reduce danger from fire caused by sparks.*



ANTI-ICING RUBBER PADS *heated electrically protect tail and wing surfaces of Canadian jet airliner. Horizontal stabilizer installations are said to be the largest single electrothermal units ever made.*

Where Electrically Conductive Rubbers Are

by **PHILIP O'KEEFE,** Associate Editor, Materials & Methods

All types of natural and synthetic rubbers can be processed so as to conduct small electric currents. . . . They are harder and generally have lower tensile strength and elongation than nonconductive types.

● ALTHOUGH RUBBER IS usually considered an electrical insulator, special rubbers have been developed with low resistance to electric currents. These materials have many limitations, but they find application in heating units, in electronic equipment, and in places where static charges must be grounded to prevent sparks. In non-electrical properties, these conductive rubbers are similar to conventional types. Any rubber can be made conductive, but the carbon black added for conductivity increases Shore hardness. Therefore, rubbers as soft as those made by conventional methods cannnot be made.

Properties

Conductive rubber is made with specially processed carbon blacks, lamp blacks and acetylene carbon blacks. The most conductive compounds are made with acetylene blacks. In nonconducting rubbers, the reinforcing carbon is well dispersed in small clusters. Although the carbon itself is a good conductor, the clusters are scattered and there are no continuous paths to carry electric currents. The special blacks used in conductive rubbers, on the other hand, show strong interparticle forces and tend to form long chain-like clusters in the rubber. These carbon chains carry electric currents, lowering the resistivity of the compound.

All types of natural and synthetic rubber and rubber cements can be made conductive. Sheet, film, filament and wire are available in low-resistivity (1-5 ohm-cm) forms. Sheet, film, filaments, wire and molded products are made with resistivities from 10 to 10^6 ohm-cm.

Conductivity increases with the amount of carbon black added. Increasing the carbon black content also effects other properties, however. It increases hardness, reduces elongation and increases tensile strength up to a point of maximum reinforcement beyond which more carbon black reduces tensile strength. For example, a highly conductive compound, one having a resistivity down around 20 ohm-cm, might typically be expected to have a tensile strength of about 1700 psi, elongation of 225% and Durometer Shore "A" hardness of 75. On the other hand, a less conductive compound, one with resistivity up around 30,000 ohm-cm, might typically have a tensile of 3400 psi, elongation of 600% and Durometer Shore "A" hardness of 50. With some synthetic rubbers, increased conductivity does not necessarily mean lower strength. The general rule, nevertheless, is that conductive rubbers are not soft, and the higher the conductivity, the harder the rubber. Conductive rubber should never be specified with hardness less than 60 Shore "A", according to one supplier.

The nature of the carbon chain conductivity mechanism in these compounds governs their use in industrial products. If a rubber stock is mixed too thoroughly in its processing, the chains are broken down and the conductivity decreases. The exact value of the conductivity cannot be predicted for this reason. The formation

Proving Useful

and the lengths of carbon chains cannot be controlled precisely in processing, in any case. Batches apparently prepared by similar methods from identical ingredients show resistivity variations up to 100 to 200%. Variations of this magnitude do not necessarily hold in the finished product, however. Sheet used for heating purposes in which conductivity values are critical, for example, can be varied in thickness to compensate for variations in the rubber. Resistivities are specified, rather than exact thicknesses. Tolerances can be held as low as 7½% with resistivities between 1 and 5 ohm-cm. Tolerances of ±10% are easier and cheaper to meet, though. With lower conductivity rubbers (10^2-10^6ohm-cm), tolerances must be wider. Calendering and extrusion also impart directional properties; resistance in one direction may be 10 times that in a perpendicular direction. These processes are not used on products in which exact conductivity is of importance. Rubber films dried from cements or latices tend to have lower resistivities than milled compounds.

The resistance of conductive rubbers varies as the material is put under stress. This resistivity change is roughly proportional to the stress. Unlike other materials, however, these rubber formulations increase in resistivity in both tension and compression. There is also a time factor involved. The resistance increases as the stress is applied; under a constant stress, however, the resistance slowly decreases again. Nor does the resistivity return to its original value immediately after the deflection is released. Continued flexing tends to increase the resistivity. This may not be true, however, when the deflection is kept below a given limiting value, which depends on the particular rubber used. The rate of increase with flexure is a function of the degree of flexure.

Temperature and chemical environment also effect the performance of conductive rubber. The useful life of any rubber is lowered at elevated tempatures due to oxidation. Conductive rubbers are no exceptions to this rule. The life of a conductive rubber at an elevated temperature will be exactly the same as the life of a comparable nonconductive rubber at the same temperature. Conductive rubbers are also affected by substances which cause swelling. This swelling is accompanied by an increase in resistivity. The original conductance may be restored by drying out the material, however.

Applications

One use of conductive rubber molded parts, film and sheet is to dissipate static electricity. Resistivities used range from 10^2 to 10^6 ohm-cm. Resistivity tolerances can be wide. Since the small static charges built up by friction are at high voltage, a highly conductive path to ground is not necessary and variations in the resistivity of the rubber are not important. Rubber ground straps on gasoline trucks are quieter and wear longer than steel drag chains. Table tops, containers, transmission belts, conveyor belts and power materials are used in plants making or handling explosives, inflammable volatile liquids and dangerous dusts. In hospital operating rooms where explosive anesthetizing gases are handled, conductive tubing, bumpers, floor mats and caster wheels prevent sparks. Conductive fabrics filter finely divided dusts and prevent electrostatic buildups. Rubber-covered rolls handling sensitized photographic paper take off static electricity to prevent fogging of the paper. Sand blast hoses are made of conductive rubber to prevent the buildup of charges that might otherwise puncture the hose walls.

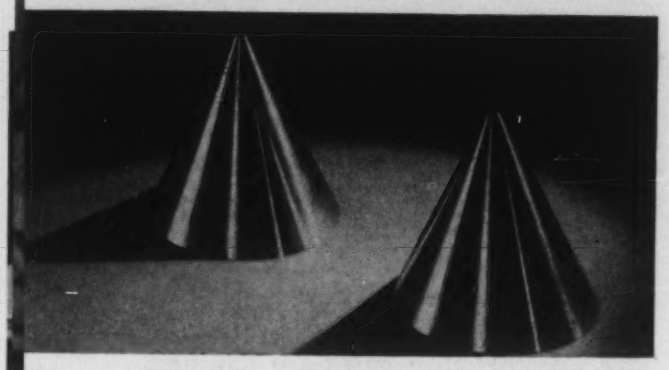
Conductive rubber films and coated fabrics are also used for electric heater elements. The material is embedded in insulation, often nonconductive rubber. Advantages are a uniform distribution of heat over broad areas at moderate temperatures, light weight, moderate space consumption, and the ability to dissipate large amounts of heat (10-12 watts/sq in.). The maximum allowable operating temperatures are limited, of course. These heating pads are used in home heating, in photographic drying equipment, and in aircraft deicing and equipment warming devices. Wear and wind and rain erosion resistance is better than with embedded wire heater pads. Conductive rubber also seems to last longer because of the fact that there are no local overheated spots. When vibration is present there is an additional advantage, since resistance wires have relatively low fatigue strengths.

Conductive rubber is used in electronic equipment. These materials absorb high frequency waves. Conductive gaskets are effective moisture seals and have desireable electrical properties in some units.

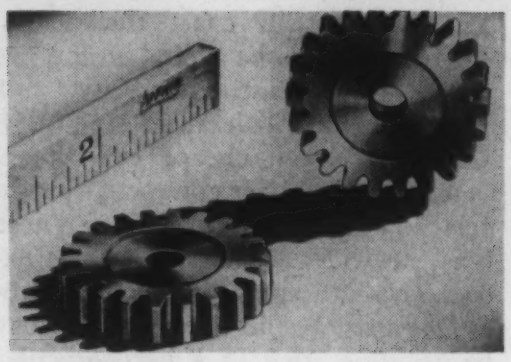
An application about which there is some doubt is the use of conductive ruber in strain gages. The limitations of the material in reliable correlation of strain and resistivity have been mentioned. Development work is still being done along these lines, however.

Use in gasoline leak detectors seems promising. When gasoline hits the rubber, it expands and the resistivity rises sharply to indicate a leak.

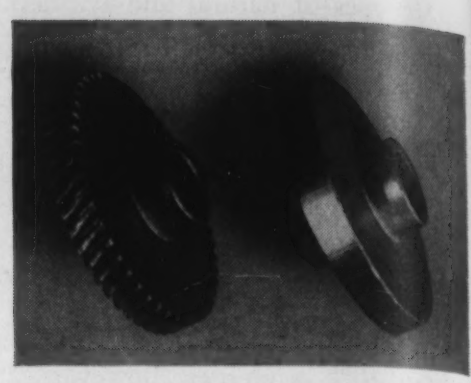
PICTURE CREDITS: *Firestone Tire & Rubber Co.; Goodyear Tire & Rubber Co.; E. I. du Pont de Nemours & Co., Inc.*



Heavy metal cones used to shield radium in radiographic logging of oil wells show the excellent machining qualities of this alloy.



Tungsten - nickel - copper alloy, Mallory 1000, counter-weight gears are shaped to precise dimensions using speeds and feeds applicable to gray cast iron.



Broaching is used extensively in producing gears from sintered blanks. Sufficient stock should be removed to prevent burnishing.

Machinability of Metal Powder Parts

One of the main advantages of pressed and sintered parts is the reduction or elimination of machining. But there are still applications where at least some machining is required to reach the final shape. Here is some helpful information on this little known phase of powder metallurgy.

by **JOHN L. EVERHART**, Associate Editor, Materials & Methods

● ONE OF THE ADVANTAGES of pressed and sintered metal powder parts is that machining is largely or completely eliminated in a great many cases. Consequently, less attention has been given to machinability than to other problems and less specific information is available. However, machining is required in the finishing of some metal powder parts where it is impossible to press the powder into the desired final shape. Thus, undercuts, large tapers, internal and re-entrant angles and lateral holes must be formed by machining. It is frequently necessary to broach or ream cored holes. It is sometimes impossible to press or coin to the desired tolerance and the part must be finished by machining.

Parts produced by powder metallurgy methods range in properties from low strength relatively soft porous bodies to high strength extremely hard carbides. The range of machining properties is also wide, but there are certain fundamentals inherent in the process which set these parts off from cast and wrought parts even when the composition is similar.

Influencing Factors

By the nature of the process, all parts are affected to varying degrees by such factors as particle size of the powders, pressing practice, sintering conditions, composition and density.

Particle size is an important factor influencing the properties of a part. Two similar compositions prepared from powders of different sizes can have quite different properties. Although not a factor in simple shapes, in complicated shapes differences in density of the piece can also occur during pressing with the center of the piece often of lower density than the ouside.

The furnace atmosphere and the manner of introducing the parts into the hot zone can also influence the properties. Thus, parts introduced directly into the hot zone can have different properties from those introduced through a pre-heat zone.

The manner in which a single factor can influence the characteristics of a metal powder part is illustrated by the effect of sintering atmospheres on the properties of beryllium parts. Sintering in argon results in diffusion only. On the other hand, sintering in a vacuum results in evaporation of some of the impurities in the compact and possibly in the decomposition of oxides. The results obtained by the two procedures are quite different. Components sintered in a vacuum are considerably more ductile than those sintered in argon, and machinability is improved by the vacuum treatment.

Sintering time and temperature can influence the properties of pieces, particularly in alloy parts. For example, a fully sintered tin bronze part could have a single-phase alpha

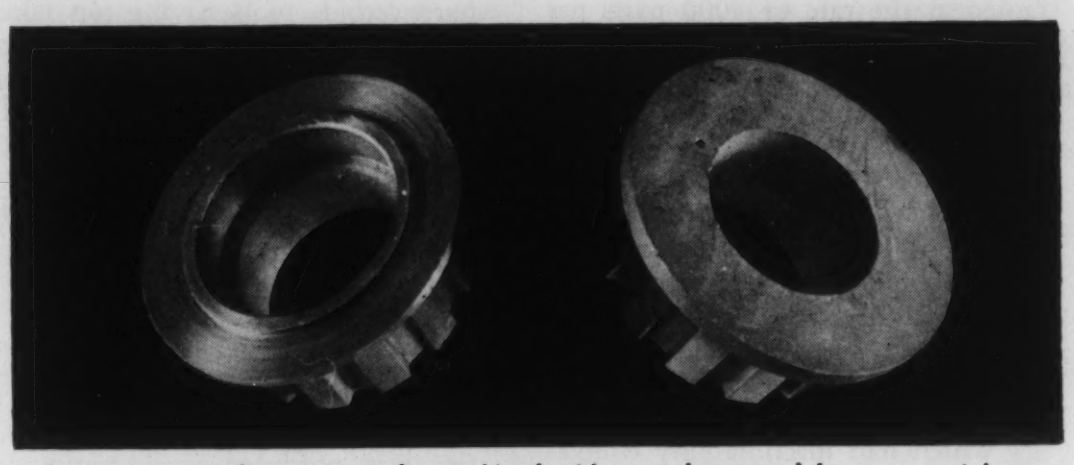
structure, while one in which sintering had not been complete might contain particles of the hard delta constituent. Although the composition would be the same, the machining characteristics of the two lots would be quite different.

The combination of all these factors can cause variations in density and hardness in an individual part, from piece to piece in a single lot or from lot to lot. These variations can make considerable difference in the relative machinability of two parts nominally of the same composition, and are probably responsible for the differences of opinion expressed by engineers. Some engineers consider metal powder parts difficult to machine. Others remark that they have no more difficulty with such parts than they do with cast or wrought material. Little specific information is available, but some generalizations are possible which will assist the engineer in attacking the problem. These are discussed in the following sections.

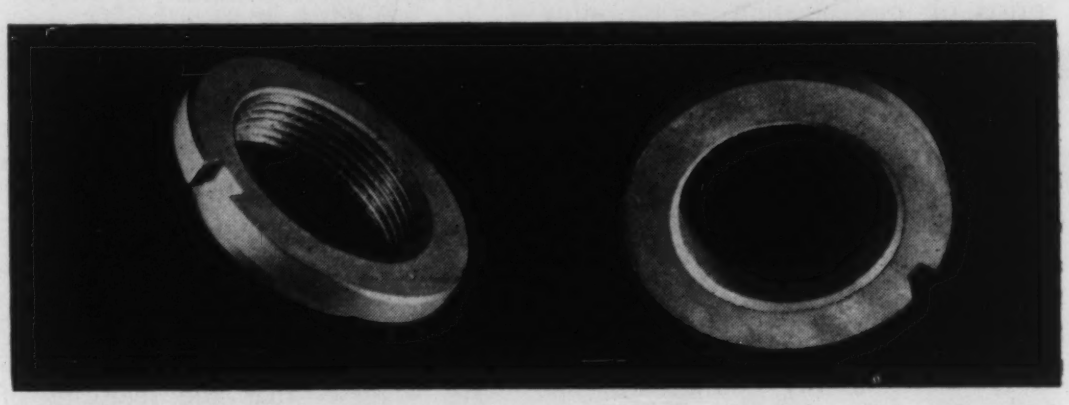
Porous Parts

A major requirement in the machining of porous parts is the retention of porosity. To accomplish this objective, carbide tools are preferred to ordinary high-speed steel tools by most organizations, and the tools should be sharp for best results. It is considered good practice to form the part sufficiently oversize to permit taking a substantial cut. Several organizations recommend that at least 0.010-in. stock should be removed. Difficulties are experienced when the part is formed very close to the final size, thus drastically limiting the machining. In such a case, perhaps only momentary contact with the part is obtained during an operation which is essentially truing the dimensions, and tool wear may be excessive. There is the further danger of burnishing the part and closing the pores. This is particularly true in broaching where removal of too little stock results in burnishing and increasing tool wear. Generally the parts are machined dry.

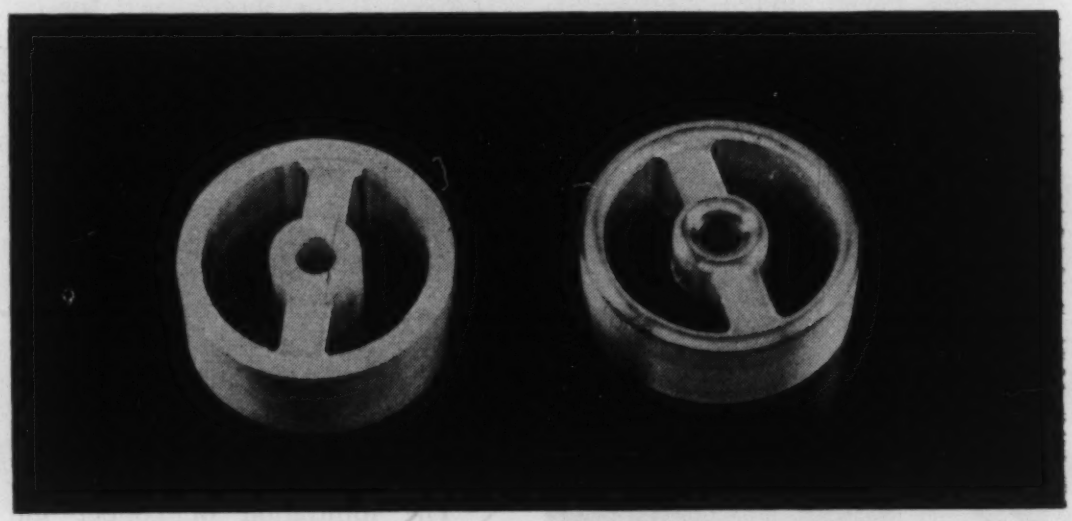
For drilling porous bronze parts, a low helix angle, left-hand spiral drill is suggested by Weller. Speeds of 70 sfm for ordinary high-speed steel tools and 200 sfm or more for carbide tools are recommended. The tools must be sharp and no coolant or lubricant is used. For tapping, two or three flute left-hand spiral-point taps are suggested because the spiral point throws the chips ahead and prevents driving them into the pores. Turning speeds of 90 to 110 sfm can be used for finishing cuts with high-speed steel tools and 175 to 350 sfm with carbide tools, while speeds of 500 sfm are possible with carbide tools for roughing cuts.



Porous iron powder parts can be machined with procedures used for gray cast iron.



Copper-impregnated iron powder components are as readily threaded as free-cutting steel.



Leaded yellow brass compacts can be machined as readily as the cast material and equal surface finishes are obtainable.

The machining of brass components has been reported to be no more difficult than the machining of cast material of similar composition. In a specific example, brass nuts were tapped for a 10/32 thread with no change in technique.

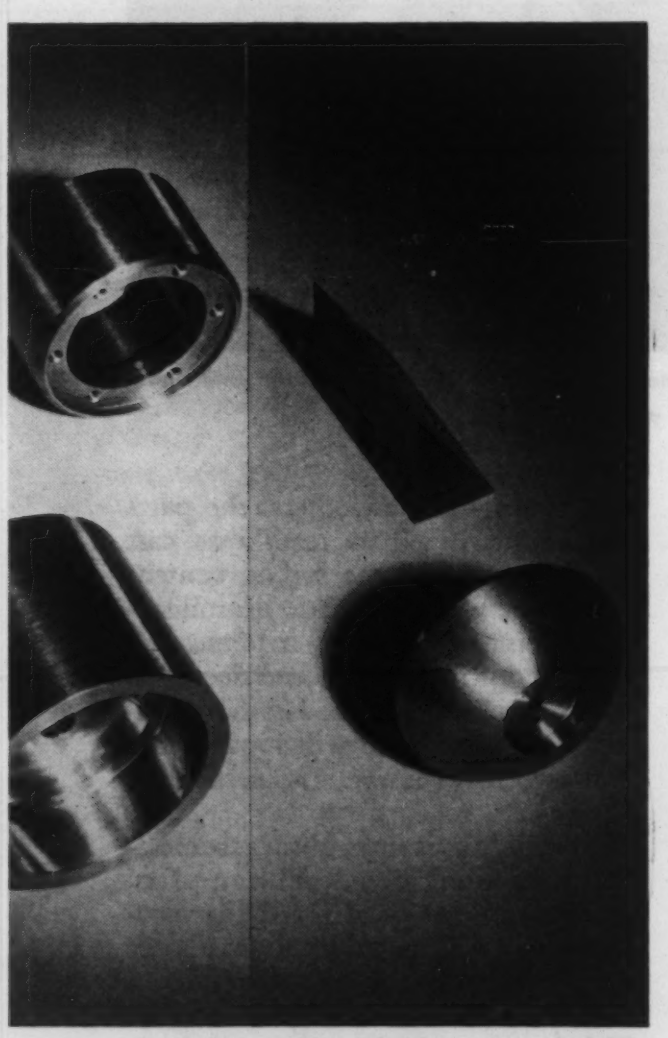
The usual iron powder part has a density of 6 to 6.2 gm per cu cm and about 15% porosity. If the carbon content is below 0.5%, according to some authorities, or below 0.8%, according to others, the parts can be machined as readily as cast iron. Increase in the carbon content above the eutectoid ratio introduces carbide into the matrix, increases the difficulty of machining, and decreases tool life. The preferred carbon content for parts which will require machining, therefore, is less than 0.8%.

Machining is not always successful in handling powdered iron parts. In one case it was decided that economies would result if a small nut was produced from powdered iron rather than from wrought material. This nut was ¼-in. square and required the tapping of a 6/40 thread. Using wrought material, a production of 50,000 parts per tap was ob-

tained at the rate of 4000 parts per hr. With powdered iron, the production fell to 2000 parts per tap. The use of powdered iron nuts was abandoned because the saving in material costs was more than offset by the increased cost of machining.

Various expedients have been used to improve the machinability of porous metal parts. It has been reported that the addition of 4% molybdenum sulfide to iron with a porosity of 15% resulted in a product which had machinability equivalent to yellow brass. At the present price of molybdenum sulfide, this method is not attractive as a commercial procedure but it is possible that a less expensive sulfide might be substituted with similar results. Other parts have been impregnated with paraffin to improve the machinability, the paraffin being subsequently removed.

Highly porous parts can be impregnated with molten salts to improve machinability. Sodium chloride is used to impregnate iron parts, but chlorides attack copper. Therefore, oxalic acid is used to impregnate copper-base compacts. After impregnation, the parts are machined with sharp carbide tools having top rake angles of 5 to 7 deg, side and front rake angles of 5 deg, and no relief. Speeds of 500 sfm, depths of cut of 0.003 to 0.005 in., and feeds of 0.004 in. are satisfactory for finishing cuts. After machining, the salt is leached out with hot water. The porous condition of the part is retained by this procedure.



Tungsten - nickel - copper alloy, Mallory 1000, can be machined readily with carbide tools to a variety of shapes.

Dense Parts

For a number of applications, parts are produced with minimum pororsity and the density approaches that of the cast or wrought material. The machining properties can be quite different from those of porous parts. Among such parts are copper-base materials, iron powder parts infiltrated with copper, Alnico magnets and high density alloys.

For the machining of copper-nickel, copper-chromium and other high copper-bearing compacts, Strauss recommends the use of carbide tools. He suggests that the majority of machining operations can be performed at the speeds used for cast or wrought parts but lighter cuts are desirable. At the same time, he notes that the combination of hard and soft spots in the compact causes rapid build-up on the cutting edge. For drilling such parts, a reduced back-rake is preferred, while for milling, the use of negative rake carbide cutters permits the use of exceptionally high speeds. Tools must be sharp. For boring, he notes that carbide tools are preferable to high-speed tools but the finish may not be as good.

The infiltration of copper into iron powder compacts has been reported to increase the machinability of the material. Parts impregnated with 7.5 to 10% copper have been given a machinability rating equivalent to free-cutting steel by one organization. High-speed steel tools similar to those used for cast iron were used with the same speeds and feeds. During cutting an oil coolant was used.

Alnico magnets made from powdered iron, nickel and aluminum are customarily machined before sintering. These materials are drilled. milled, tapped and threaded after pressing or presintering, generally using carbide tools. After sintering the magnets are hard and difficult to machine. Final dimensions are generally obtained by grinding.

Although tungsten is very difficult to machine, high density alloys, containing more than 90% tungsten, can be machined quite readily. It is reported that the machining properties of these materials resemble those of medium soft steel. However, the metal is somewhat abrasive and carbide or diamond-tipped tools give best results. Normal turning or boring practice can be used at surface speeds of 400 to 500 sfm with carbide tools. Use of a coolant is advisable. Procedures similar to those used for gray iron are satisfactory for milling and shaping high density alloys. In drilling, normal speeds and feeds are recommended, although provision must be made to clear the drill flutes since no continuous chip is formed. A coolant or cutting oil is suggested to increase tool life.

Carbide Parts

The machining of carbide parts is often done in an intermediate stage of production. The parts are pressed to the desired form and presintered. In this condition they have the consistency of chalk, but can be handled if care is used. Since they are abrasive, they are machined with diamond tools or ground with diamond wheels to the desired size, which must be somewhat over the final dimensions to compensate for the shrinkage that occurs during sintering. After sintering they can be ground on a diamond wheel. As with so many other reports, no tool life figures are available, partly because of the nature of the operation. Instead of productions running into thousands of parts, as is customary with many metal powder components, generally carbide part production is limited to a few hundred or a few thousand pieces.

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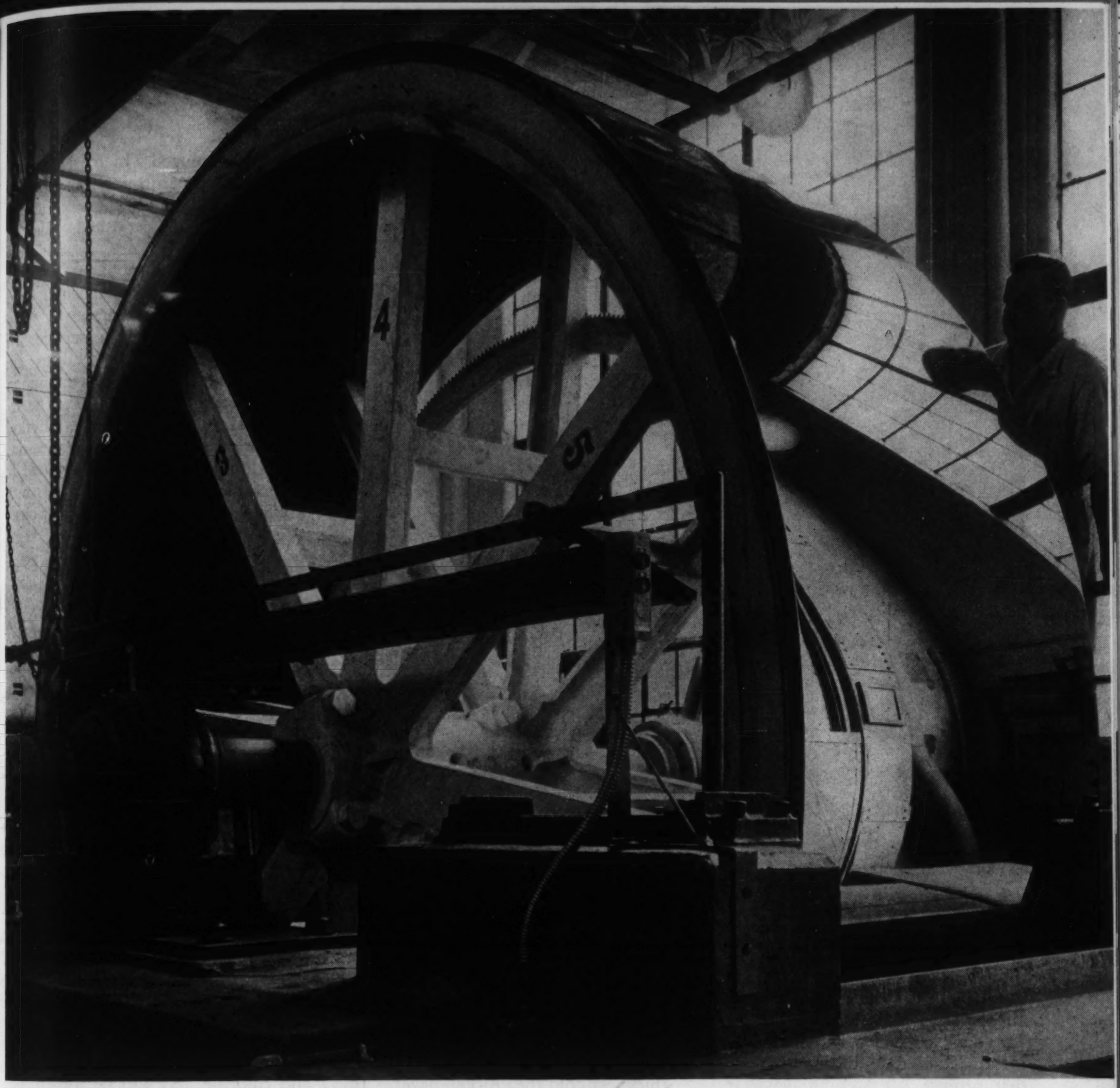
Sylvania Electric Products, Inc.

PICTURE CREDITS: *Presmet Corp.; P. R. Mallory & Co., Inc.; International Business Machines Corp.*



Nickel plated cast iron film casting wheel.

Properties of Electrodeposited Nickel

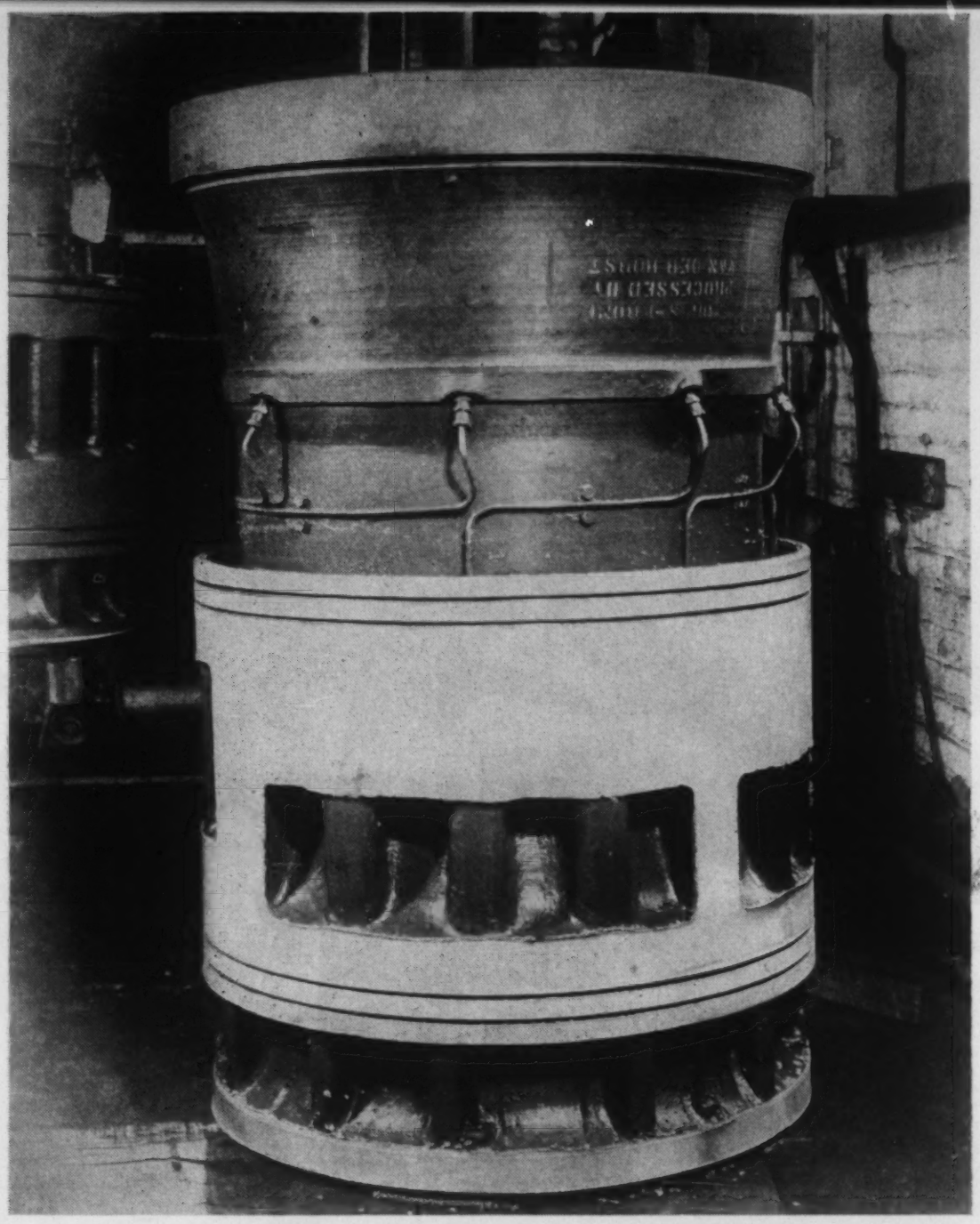
.... and What Influences Them

by **WILLIAM A. BLUM**

By carefully controlling the conditions of deposition, nickel coatings and electroformed parts can be produced to meet exacting service requirements.

During the past five years the American Electroplaters' Society, through its Research Committee supported by the active sustaining members of AES, has sponsored an extensive research at the National Bureau of Standards on the properties of electrodeposited nickel. The present article is based on a report issued through the Research Committee of the AES in the August 1952 issue of "Plating" and written by V. Zentner, A. Brenner and C. W. Jennings.

● ELECTRODEPOSITED NICKEL is widely used as a coating on metals and for electroforming parts. In these applications it is possible to so define and control the conditions of deposition as to obtain rather closely a given set of physical properties. To provide data that will serve as a guide in the production of such "hand-tailored" deposits, an extensive investigation was sponsored by



Heavy nickel plating on large diesel cylinder liner, 0.030 in. per side.

the American Electroplaters' Society at the National Bureau of Standards. This article is largely based on the information and data obtained in that project.

Uses of Electrodeposited Nickel

The most important commerical applications of nickel deposition are in electroplating and electroforming. Electroplating involves the deposition of adherent metal coatings in order to change the properties of the surface and thereby improve the appearance, protective value or wear resistance of the surface layer. Electroforming involves the production or reproduction of articles by electrodeposition.

Electroplated nickel coatings are extensively applied to steel, zinc, brass and other metals in order to protect them against corrosion and to improve and maintain their appearance in service. Almost all of the commercial nickel coatings are covered with a very thin layer of chromium (about 0.00002 in.) which resists tarnish in the atmosphere. Numerous studies have shown that the protective value of these electroplated coatings depends largely upon the thickness of the nickel layer. In coatings used for protection and decoration, the nickel layer is usually from 0.0005 to 0.003 in. thick, and is sometimes preceded by a layer of copper. Some other applications of nickel plating employ thicker nickel coatings, *e.g.*, on chemical equipment to resist attack, and in the "building" up of new, worn or defective parts.

Typical examples of electroforming, in many of which nickel deposition is used, are the production of electrotypes and similar printing plates; the manufacture of dies for forming phonograph records; and the production of articles such as fountain pen caps, Pitot tubes (used to measure air velocities), various molds and dies, and thin-walled tubes and sheets, and in fine screens used in filters and in printing. In electroforming of nickel, deposits with thicknesses of 0.1 in. or more may be employed. In most applications of electroforming the physical properties determine the selection of the metal to be deposited. Electroformed coatings are usually detached from the mold or mandrel on which they are deposited, and must therefore of themselves withstand the conditions of service. In contrast, electroplated coatings are adherent and usually derive support from the underlying metal. The results of this study of the physical properties of nickel are, therefore, most likely to be directly applied in electroforming, a process that is now finding new promising applications.

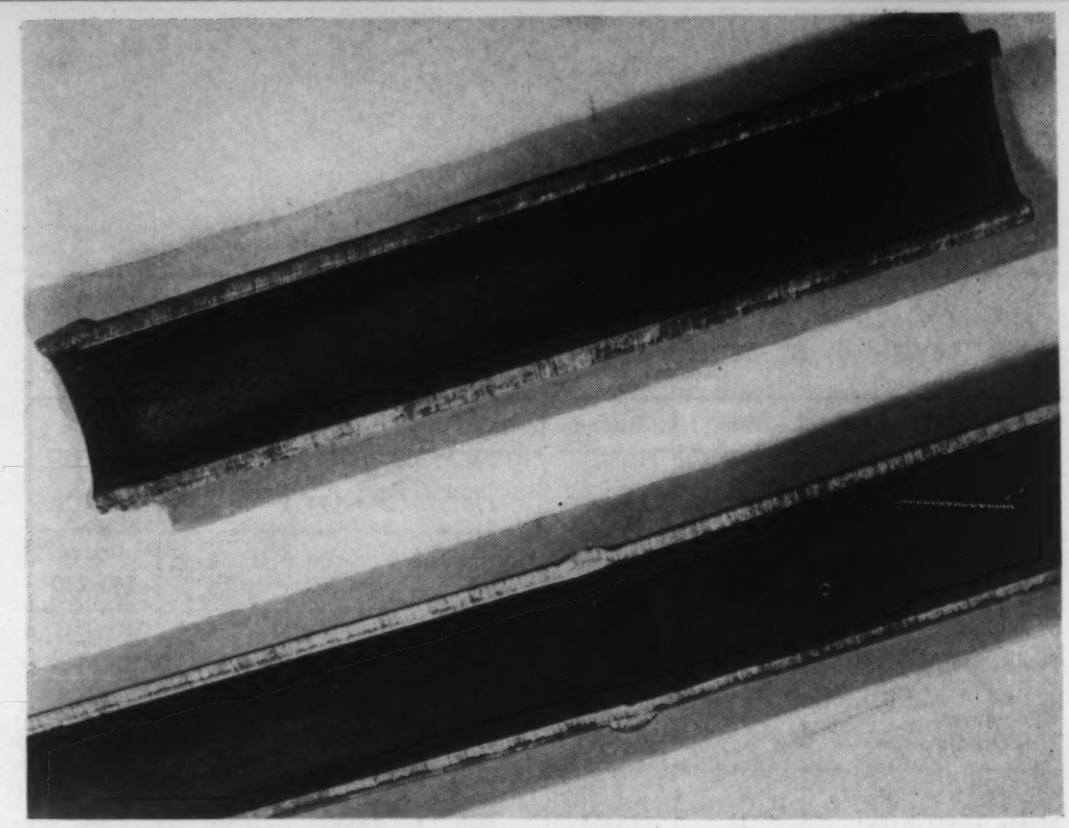
Baths and Types of Deposits

In this investigation deposits were made from 20 different nickel baths under a wide variety of conditions, yielding about 250 deposits whose properties were measured. The research was not confined to those properties that are of obvious present importance. Other properties were measured (1) because they may become important for special applications, and (2) because they may throw light on the cause and control of variations in the more important properties. The structure of many of the deposits was examined microscopically, and a few were studied with x-rays and the electron microscope. Chemical analyses of many of the deposits were made, including the determination of metals such as cobalt, and of nonmetallic inclusions of oxygen, hydrogen, carbon, sulfur and chlorine. As will be shown, the composition and structure of electrodeposits are closely related to their physical properties.

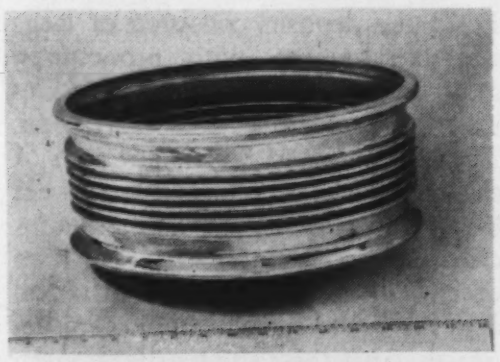
Much of the nickel plating and electroforming is now conducted from the "Watts" bath, or modifications of it. A typical formula for a Watts nickel bath is as follows:

Constituent	*N Normality*	Gm per *Liter*	Oz per *Gal*
Nickel Sulfate	1.5	210	28
Nickel Chloride	0.5	60	8
Total Metallic Nickel	2.0	60	8
Boric Acid	0.5 (*M*)	30	4

The exact composition and concentration of such a bath may be varied somewhat without making a marked change in its behavior. In this investigation, baths were also used in which the ratio of nickel chloride to sulfate was varied, while keeping the total nickel content equal to 60 g per l or 8 oz per gal (*i.e.*,



Sectioned tubing shows result of nine months exposure in gas condensate well. Top, nickel plated tubing from inlet. Bottom, nickel plated tubing (left) and carbon steel tubing (right) from outlet.



Electroformed nickel elliptical bellows for air conveyor system in a large aircraft. Part operates at 500 to 600 F.

he total "normality" of the nickel alts was 2 *N*). In a few experiments he ratio of nickel chloride to sulfate as kept the same as in the Watts ath, but the total concentration was ncreased to 4 *N* or decreased to 1 *N*.

In other baths, additions of inorganic salts, such as sodium, potassium or ammonium salts, were made to the Watts bath. The "bright" nickel baths contained organic brighteners added to a Watts bath. In addition, some deposits were made from "fluoborate" nickel baths and from alkaline ammoniacal nickel baths. Practically all the baths used contained boric acid, which is commonly added to the amount of about 30 g per l or 4 oz per gal. Some nickel deposits were tested that were made from proprietary bright nickel baths that contained addition agents whose compositions were not disclosed.

Most of the baths were made from commercial nickel salts, which contained about 0.5% as much cobalt as nickel; but for comparison, a few baths were prepared with cobalt-free salts and operated with cobalt-free nickel anodes. All the baths were purified initially and at intervals to remove metallic or other impurities. In a few cases hydrogen peroxide was added to prevent pitting.

Each bath was operated over a wide range of pH (acidity), usually from pH 2 to 5.5; at temperatures from 50 F to 150 F; and at current densities from 5 to 100 amp per sq ft. Electrolytic nickel anodes that contained over 99.5% nickel (plus cobalt) were used.

Two types of deposits were made for these tests: (1) nickel sheets deposited on and stripped from stainless steel, and (2) nickel tubes deposited on copper tubes which were later dissolved out with chromic and sulfuric acids.

Properties of Nickel Deposits

Cathode Efficiency — The cathode efficiency expresses the proportion of the current that is actually used to deposit metal. In practically all the experiments, the cathode efficiencies were over 90%, and were usually above 95%. Hence, no special consideration need be given to this factor.

Internal Stress—It is well known that during the electrodeposition of metals, especially of hard metals such as nickel, iron and chromium, large internal stresses may be set up. These are usually "tensile" or "contractile" stresses which tend to cause the metal deposit to bend so as to make concave the last surface deposited. (Under rare conditions "compressive" stresses of much smaller magnitude may arise.) Internal stress may be very objectionable in electroforming because when the supporting mold or mandrel is removed, the remaining nickel shell may become distorted. A knowledge of the factors that increase the stress, and means of reducing and controlling the stress, are therefore especially desirable for electroforming operations.

In this study the stress was measured by means of the "spiral contractometer," devised by A. Brenner of the National Bureau of Standards. The results showed that in the Watts type bath the stress in unpurified solutions may be as high as 50,000 psi. If, however, the solutions are carefully purified and are operated with adequate control, the stress in Watts bath deposits may be reduced to about 15,000 psi, which is usually not objectionable. By certain organic additions the stress may be still further reduced, or even reversed. The data on stress obtained in this investigation and in other studies on nickel deposition will enable an operator to so control the stress in nickel deposits as to avoid serious difficulties from that source.

Density (Specific Gravity)—This was determined as a measure of (a) the soundness of the deposits, *i.e.*, their freedom from pores or holes; and (b) the possible presence of nonmetallic impurities such as oxides, that reduce the density and may affect the physical properties. In most of the deposits the density was close to the value of 8.91 g per cu cm, calculated for a perfect nickel lattice.

Coefficient of Thermal Expansion—This property is involved in certain applications of nickel deposits, and is related to other properties. The expansivity may be important if a metal such as steel with a heavy nickel coating is subjected to high temperatures in use, or in welding or forming operations. In the range from 68 to 1110 F the average coefficient of expansion of Watts nickel is 15.6, practically identical with that of pure rolled annealed nickel and close to that of steel. Some bright nickel deposits show erratic expansivities.

Hardness—The hardness was measured by either the Vickers or the Knoop indentation method. This is a very important property of nickel for those applications that demand good wear resistance, *e.g.*, on printing plates. Because the hardness is closely related to the tensile strength and ductility of the deposits, it serves as a convenient means of characteriz-

Typical Properties of Nickel Deposits

Property	Group I Watts Type Fluoborate		Group II Nickel Chloride		Group III Bright Ammoniacal	
	Ave.	Range	Ave.	Range	Ave.	Range
Hardness-Vickers	192	140–400	270	200–390	467	350–820
Tens. Str. 1000 lb/in.^{2}	78	50–115	108	90–150	183	140–220
Elongation, %	19	2–31	9	4–17	3	1–5
Elect. Resist. Micro Ohm-Cm	8.3	7.5–11	8.7	8.5–11	12.2	8.5–36
Stress, 1000 lb/in.^{2}	31	15–54	40	25–55	—	—

ing a deposit. Deposited nickel may be obtained with hardness from 150 to 800 Vickers, according to the conditions of deposition.

Tensile Strength and Elongation (Ductility) — These properties were measured on flat tensile specimens by the customary methods. In general, the tensile strength is parallel to the hardness, while the ductility changes inversely with the hardness and tensile strength. The tensile strength may be from 50,000 to 200,000 psi and the elongation, from 5 to 35%.

Young's Modulus of Elasticity— Young's modulus of elasticity varied from that for regular rolled nickel to 20% lower, and did not differ much with the conditions of deposition.

Electrical Resistivity (Conductivity)—This was measured on tubular specimens. For most industrial uses the conductivity is not important, but the measured values are related to the purity and other properties of the deposits.

Magnetic Properties—The measurement of magnetic properties was made because these are sometimes important in the selection of a metal coating or deposit, and also because they are related to other properties. They are involved in the measurement of the thickness of nickel coatings by such devices as the "magne-gage."

Effects of Annealing—Certain of the above properties were measured in the "as-deposited" condition and also after the deposits were annealed at 750 and 1800 F. The observed changes in properties and structure throw light on the relations between these factors. In general, it was found that only minor changes in structure or properties were produced by heating dull nickel deposits to temperatures up to 750 F. After being heated at temperatures from 1100 to 1800 F, all the deposits consisted of large equi-axed grains, with pronounced grain boundaries at which any oxides or other impurities were segregated. The hardness and tensile strength of the ordinary nickel deposits were thereby decreased. The elongation increased up to about 750 F, but then decreased. Most of the bright nickel deposits showed much larger decreases in hardness and tensile strength when heated, and showed no increase in their initial low ductility. Many voids were produced on heating the bright nickel.

Influence of Bath Composition On Properties

Effect of Cobalt — Comparison of the deposits made from cobalt-free baths and from those containing 0.5 to 1.0% of cobalt shows that the resultant low cobalt contents of the latter deposits have no significant effect on the physical properties except the electrical resistivity. In general, the cobalt increased the resistivity (reduced the conductivity) of the nickel deposits. It is not readily possible to define the exact magnitude of this effect, because the cobalt content of a deposit produced from a bath with a given cobalt content varies with the pH, temperature and current density. There are few if any applications in which this variation in the electrical resistivity of nickel deposits is significant.

Type of Bath—With respect to the resultant physical properties, the various nickel baths may be divided into three distinct but not sharply defined groups.

Group I includes the Watts type baths, containing both nickel sulfate and chloride (and boric acid) with the nickel sulfate concentration greater than that of chloride, and with total metallic nickel contents of 4 to 16 oz per gal. These baths, with additions of sodium, potassium or ammonium sulfate or chloride, and also the fluoborate nickel baths, fall in this group.

Group II includes baths containing only nickel chloride, or principally nickel chloride with smaller contents of nickel sulfate or nickel acetate.

Group III includes the "bright" nickel baths, most of which contain organic addition agents, and the alkaline baths with an excess of ammonia.

Some of the important physical properties of these three groups of nickel deposits are summarized in the accompanying table.

From the table it may be seen that going from Group I to II to III, hardness, tensile strength, electrical resistivity and internal stress tend to increase. No values for stress of Group III deposits are included in the table because many of the bright nickel deposits were supplied with no data on stress. It is known that in bright nickel baths the stress may vary from fairly hight values to zero or negative values, depending upon the organic addition agents used.

There is a corresponding decrease in the ductility, as measured by the elongation. Data in the original tables also show that there is an increase in the coercive magnetic force, *i.e.*, the resistance to demagnetization; and a decrease in the magnetic permeability, *i.e.* the ease of magnetization.

Nickel Content — For most nickel baths a variation in the nickel content from 4 to 8 oz per gal has little effect on the physical properties. An increase up to 16 oz per gal of nickel yields somewhat harder deposits.

Chloride Content — The presence of some nickel chloride along with the nickel sulfate produces softer, more ductile deposits than do either pure sulfate or chloride baths. In general, a ratio of one equivalent of chloride to three of sulfate (as generally used in the Watts bath) produces the softest, most ductile deposits.

Bath pH—The pH (or acidity) of nickel baths has very important effects on the physical properties of the nickel deposits. In general, if the pH is 5 or above, there is a marked increase in the internal stress, the hardness and the tensile strength; and a decrease in the ductility of the de-

posits. If hard, strong, nickel deposits are desired, it is not practicable to operate baths at a pH above 5, because then the high stress and low ductility foster cracking and flaking of the deposits.

In most nickel baths at a pH of about 3 there is a minimum value of hardness and tensile strength, and a maximum in ductility. Hence, it may be necessary, especially in electroforming, to control the pH closely; otherwise, for example, a change in pH may either increase or decrease the hardness. For most electroplating operations, the variation in properties between pH 2 and 5 is not important.

Influence of Operating Conditions On Properties

Bath Temperature—In general, an increase in bath temperature yields softer, more ductile deposits. However, in the Watts bath, raising the temperature above 140 F yields harder deposits.

Current Density—In general, an increase in current density up to 100 amp per sq ft increases the hardness and tensile strength of the deposits. However, in the Watts bath, a minimum hardness occurs at about 50 amp sq ft.

Composition of Deposits

It has long been known that sound metal electrodeposits, especially of iron, nickel, cobalt and chromium contain small but measurable amounts of hydrogen and oxygen, and deposits from certain baths may also contain small amounts of carbon, sulfur, or chlorine. Many early investigators attributed the hardness of nickel deposits to their content of hydrogen. In more recent years this hardness has been more commonly ascribed to the presence of oxides, hydroxides or basic salts in the nickel deposit. The results of this investigation confirm the latter view.

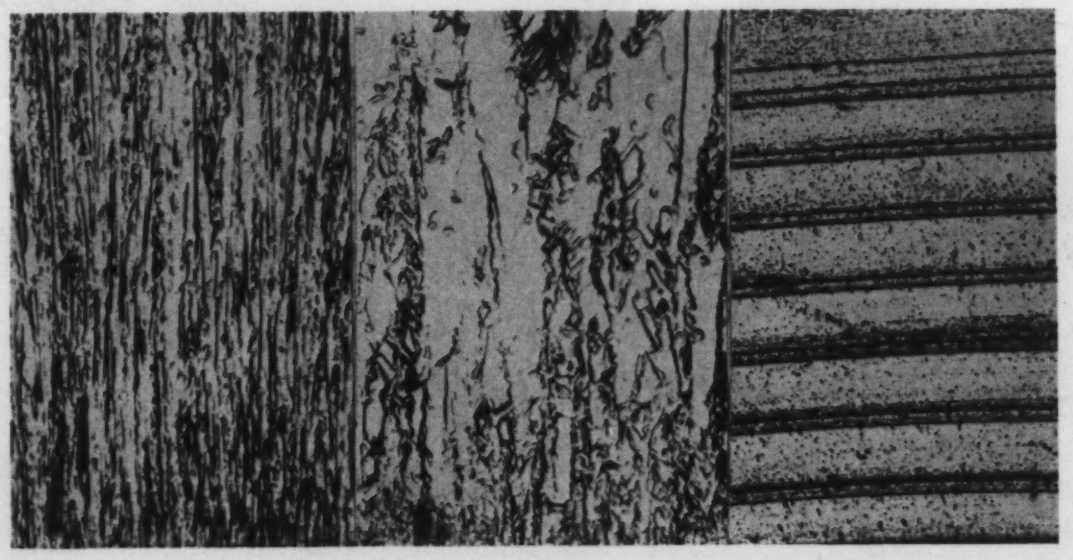
In general, an increase in the oxygen content of deposits results in an increase in hardness and tensile strength and a decrease in ductility. This relation is most evident if the pH of the bath is increased to 5 or above, which causes an increase in the oxygen content. This effect is most readily explained by the well known fact that during nickel deposition the pH of the "cathode film," *i.e.* the layer of solution immediately adjacent to the cathode surface, is higher than that in the body of the solution. If the pH of the cathode film approaches 6, there is a tendency for "hydrolysis" of the nickel salts, with the precipitation of nickel hydroxide or a basic salt. Especially if this is in a colloidal form, it is likely to be occluded in the nickel deposit. An increase in the pH of the bath or in the current density will increase the pH of the cathode film and hence will increase the oxygen content of the deposit. The small amounts of carbon, sulfur or chlorine found in certain bright nickel deposits probably account for their relative hardness and low ductility.

Structure of Deposits

The structure of deposited nickel, as observed under the microscope, is related to the composition and properties of the deposits. In general, nickel deposits with a fine-grained structure have relatively high contents of oxygen and are harder and less ductile than those with a coarser structure. It is not possible to identify the exact form or location of the oxide in nickel deposits, but it is certainly very finely distributed. Its presence no doubt hinders growth of the nickel crystals during deposition, and thus leads to smaller and more numerous crystals.

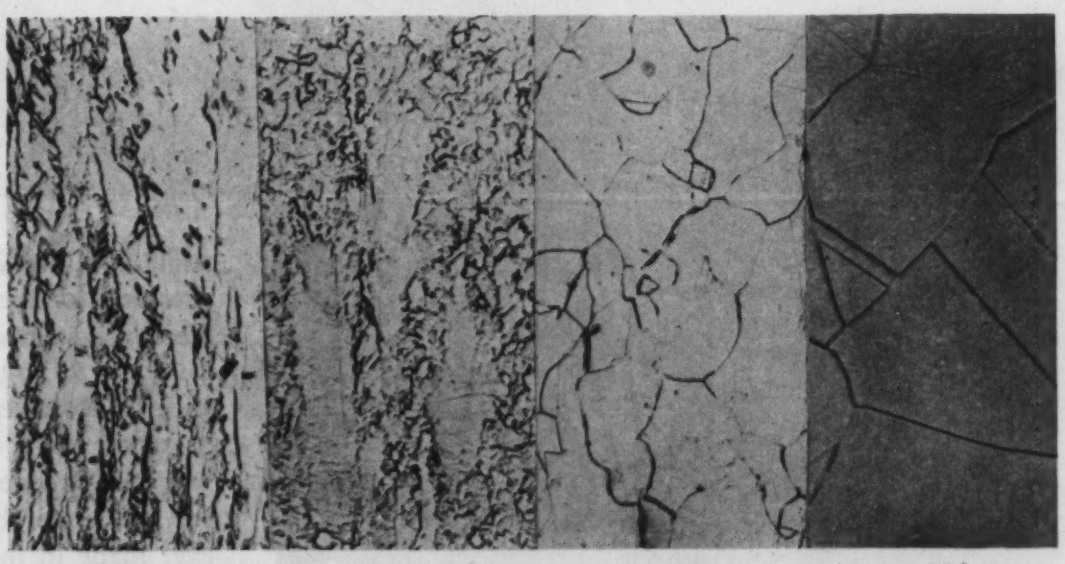
Typical structures of nickel deposits are shown in the accompanying micrographs. B represents a coarse-grained columnar nickel deposit, such as is usually produced at a low pH. F is a fine-grained fibrous deposit, made at a high pH. C is a typical banded nickel deposit which is produced in many of the bright nickel baths.

The effect of annealing upon the structure of nickel deposits is shown below. There is little change up to 750 F, but at 1480 F recrystallization occurs, and is very marked at 1830 F.



(A) (B) (C)

Typical structures of electrodeposited nickel. (A), fine-grained fibrous structure; (B), coarse-grained columnar structure; (C), bonded structure.



(D) (E) (F) (G)

Effect of heat treatment on structure of electrodeposited nickel. (D), as-deposited; (E), heat treated at 752 F; (F), heat treated at 1472 F; (G), heat treated at 1832 F.

PICTURE CREDITS: *International Nickel Co., Inc.; Super Matrix Corp.; Bart Manufacturing Co.*

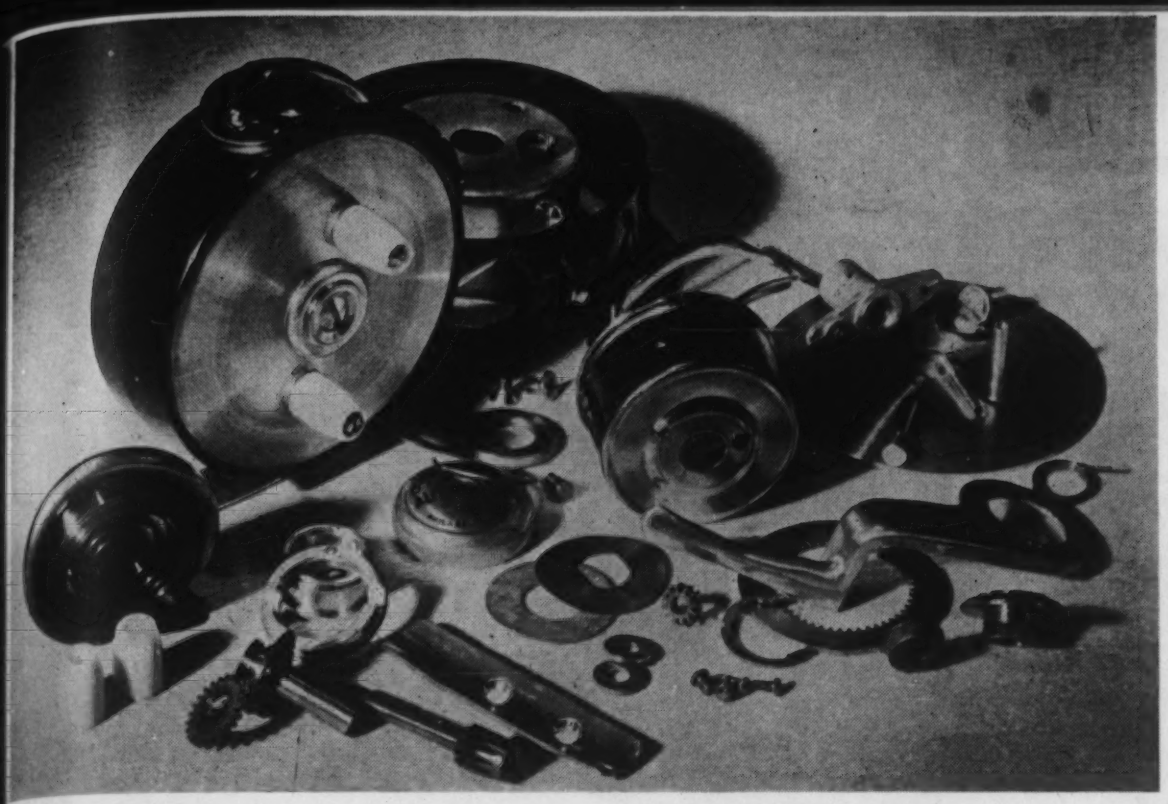
Materials at Work

Here is materials engineering in action . . .

New materials in their intended uses . . .

Older, basic materials in new applications . . .

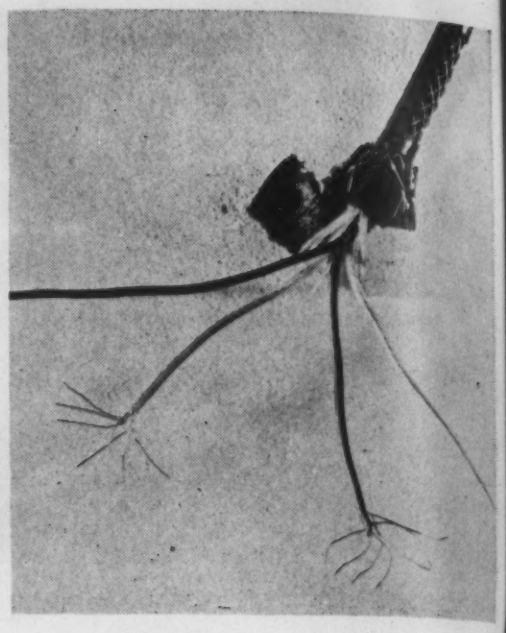
Aluminum Bronze Turbine Runner Aluminum bronze was specified for the runner in a turbine at a Western hydroelectric development. The cuprous alloy was chosen because of its high corrosion resistance, along with resistance to abrasion and cavitation. High strength and ease of repair were other considerations. The turbine runner was cast in one piece at the foundry of Ampco Metal, Inc., and is probably the largest aluminum bronze casting ever made in the United States. A total of 25,000 lb of metal was poured into the 12- by 14- by 10-ft high mold. The finished piece will weigh about 12,000 lb, and will be about 8 ft in dia and 4 ft high.



Materials in Automatic Fly Reel The Ocean City Manufacturing Co. No. 90 Automatic Fly Reel is an example of a supposedly simple product with an interesting materials engineering problem. Strength, corrosion resistance and fabricating problems were considered in choosing the material for each of 27 different parts.

DESCRIPTION	MATERIAL	REASON FOR SELECTION	METHOD OF FABRICATION, FINISH, ETC.
Housing	Aluminum alloy 218	*Light weight, high strength, good machining properties & acceptance of anodic finish. Very high corrosion resistance*	Die cast, turned, pierced, drilled, tapped, polished, anodized
Stand	Aluminum alloy 75S-T6	*High strength, resistance to atmospheric corrosion, light weight*	Pierced, blanked, swaged, formed, countersunk, burnished
Line Guide	¼ hard brass	*Corrosion resistance, strength & good base for plating*	Pierced, blanked, formed, polished nickel & chromium plated
Spring Cup	#4 temper dead soft cold finished steel	*High strength, ability to take relatively deep draw*	Pierced, cupped, drawn, notched, burnished nickel plated
Shaft Sleeve	Free turning phosphor bronze rod Anaconda 610	*Relatively strong & tough, low coefficient of friction & high resistance to wear*	Turned, drilled, reamed, broached, centerless ground burred
Housing Collar	Aluminum alloy 11S-T3	*Corrosion resistance, easy machining, light weight*	Screw machine
Drive Shaft	Aluminum	*Light weight, corrosion resistance*	Die cast
Gear Stud	B1113 screw stock cold finish	*High strength, wear resistance*	Screw machine
Intermediate Pinion	303 stainless steel	*High strength, corrosion resistance*	Screw machine hob teeth
Large Gear	Clock brass HIS	*Corrosion resistance, easy to pierce, shave & hob*	Punch press, gear hobbed
Ring Gear	Clock brass HIS	*Corrosion resistance, easy to pierce, shave & hob*	Pierced, blanked & shaved. Nickel plated
Pinion Shaft	B1113 cold finished steel	*High strength, wear resistance*	Turned, drilled & centerless ground
Brake Control Arm	Aluminum	*Corrosion resistance, good surface finish, low cost fabrication*	Die cast, filed, drilled, polished, anodized
Brake Release	Aluminum 11S-T3 bar	*High corrosion resistance, easy machining*	Screw machine & mill slots
Gear Sleeve Lock Pin	18% nickel silver	*High resistance to corrosion*	Screw machine
Brake	B1113 free turning cold finish rod	*High strength, wear resistance*	Turn, pierce & case harden
Cap Nut	Aluminum alloy 11S-T3 bar	*High corrosion resistance, easy machining*	Screw machine
Spool Hub	Aluminum 2S-O	*High corrosion resistance, drawing qualities, work hardens to proper hardness in forming operation*	Pierced, blanked, drawn, chemical dipped & turned
Spool Flange	Aluminum alloy 52-S	*High corrosion resistance, high strength and hardness*	Pierced, blanked, formed, turned & anodized
Spool Sleeve	Free turning brass rod	*Corrosion resistance, easy machining*	Drilled taper reamed, turned, knurled, threaded, countersunk, straddle milled, nickel & chromium plated
Spool Screw	Free turning brass rod	*Easy machining, good base for plating*	Turned, slotted, barrel nickel and chromium plated
Spool Screw Retainer	Free turning brass rod	*Easy machining, good base for plating*	Turned, drilled, Roto-burnished, nickel & chromium plated
Tension Washer	Phosphor bronze Grade A spring temper	*Corrosion resistance, strength & wear resistance*	Pierced, blanked formed & plated
Spool Nut	Aluminum alloy 11S-T3	*Corrosion resistance, easy machining, light weight*	Turned, knurled, stencilled & assembled

Materials at Work



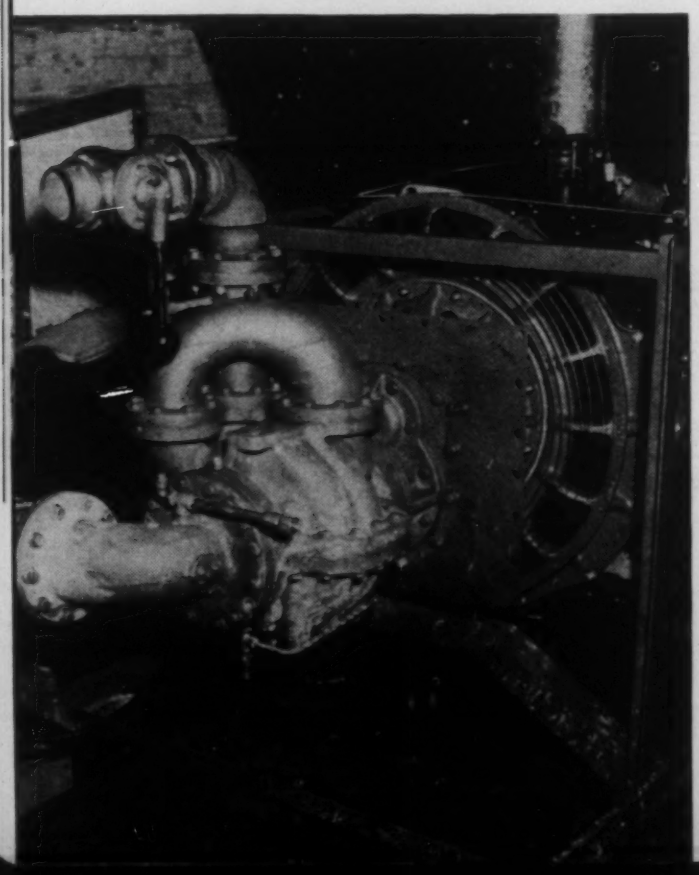
Plastic Cable Insulation A new type of carrier cable developed by the U. S. Army Signal Corps is claimed to have ten times the impact resistance, five times the frequency range, weighs about one-third less, yet costs about one-third less than the old type used in World War II. Insulation made of Bakelite polyethylene and outer jacketing made of a new Vinylite plastic make possible these improvements in the new multichannel carrier communications cable, known as Spiral-4 cable.

Redesigned with these materials, the cable has greater stability of electrical characteristics, does not vary appreciably with flexure and use, and effectively minimizes crosstalk and induction noise. The cable performs satisfactorily over a wider temperature range, resisting moisture and corrosion in high-humidity tropic regions or sub-zero cold. The new Spiral-4 cable will eventually replace all the old carrier cable for armed force tactical usage.

From the center out, the cable consists of: (1) four conductors of seven-strand copper wire; (2) each covered by extruded Bakelite polyethylene insulation, then wound in a spiral and held firmly together in a star quad configuration by (3) a belt of extruded Bakelite polyethylene. Over the belt (4) carbon-impregnated textile tape is wrapped for electrostatic stabilization followed by (5) stainless steel braid to furnish high tensile strength and yet avoid build-up of electrical losses at 60 kc. Extruded over the steel braid (6) is the jacket of Vinylite plastic QG-5924.

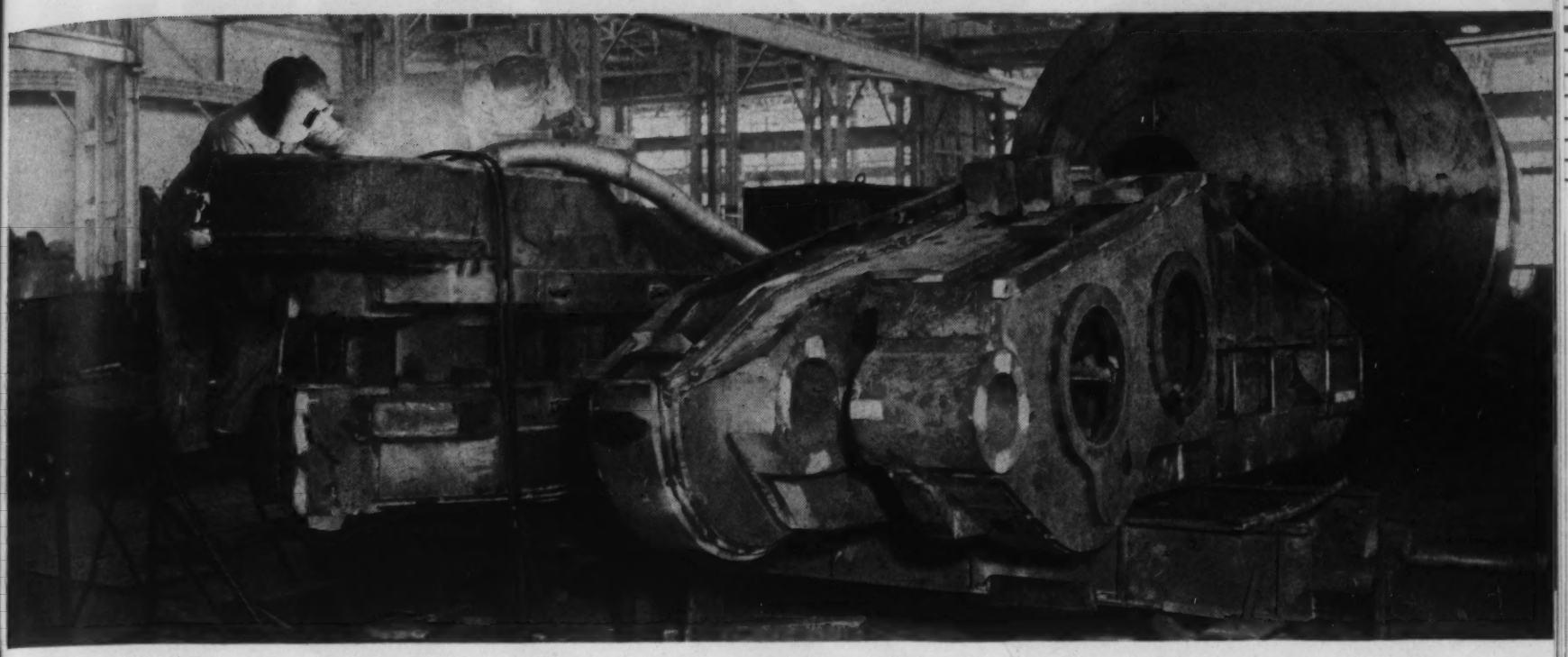
Maximum operating range for the Vinylite plastic extends from 140 deg down to –67 F. Half-inch cable jacketed with this compound will meet a 2-in. dia cold bend test at –67 F. The new compound maintains excellent abrasion resistance, hardness, toughness and deformation resistance throughout this wide range of temperature.

Combining good dielectric properties and resistivity with strength and light weight, Bakelite polyethylene permits a reduction in the weight of Spiral-4 cable and the amount of copper used, and consequently cuts the cost of manufacture from $850 which the old cable would cost today, to $600 per mile. Extrudable over wire to tolerances of ±0.003 in., the polyethylene insulation also minimizes electrical unbalances that cause electromagnetic and electrostatic induction noise in the transmitted message.



Aluminum Pump Bodies with Thread Inserts By changing from cast iron to aluminum for the bodies of their Zey series fire pumps, the engineers of Hale Fire Pump Co. reduced the weight of each pump from 600 to 350 lb. In designing for aluminum, however, there arose the problem of thread strength in the 70 tapped holes by which the bodies are assembled. Without reinforcement, the aluminum threads would not safely stand up under a hydrostatic test pressure of 800 psi.

The manufacturer solved this with stainless steel Heli-Coil thread inserts. Two 5/16-18 inserts are used in the head casting, 10 5/8-18 inserts in the body and 58 inserts of 7/16-20 size in the packing housing and body. The small inserts (5/16) are installed manually with a hand inserting tool supplied by Heli-Coil Corp. which manufactures the inserts. The larger size inserts (7/16 and 5/8) are installed with portable electric tools. In preparing the casting to receive the inserts, standard tap drill sizes are used and taps supplied by the insert manufacturer form the threads that receive the inserts.

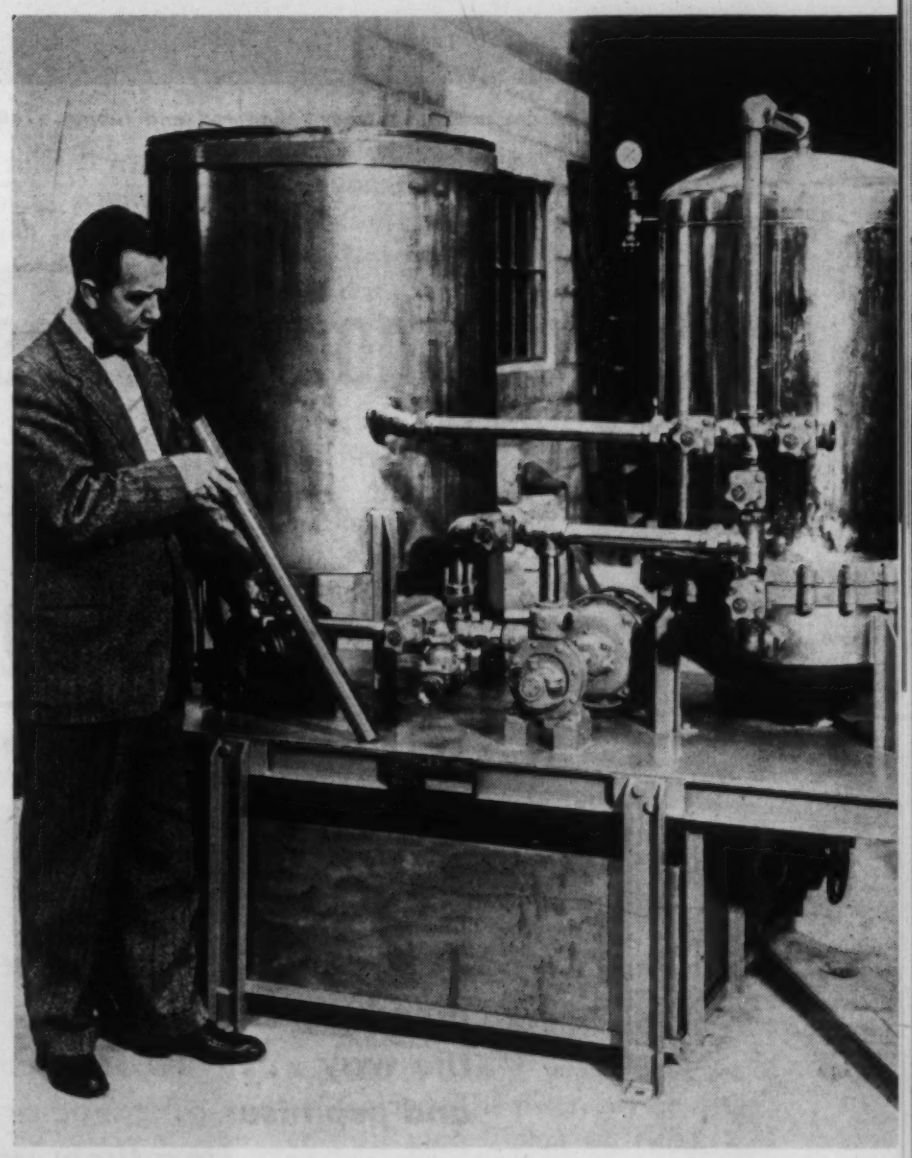


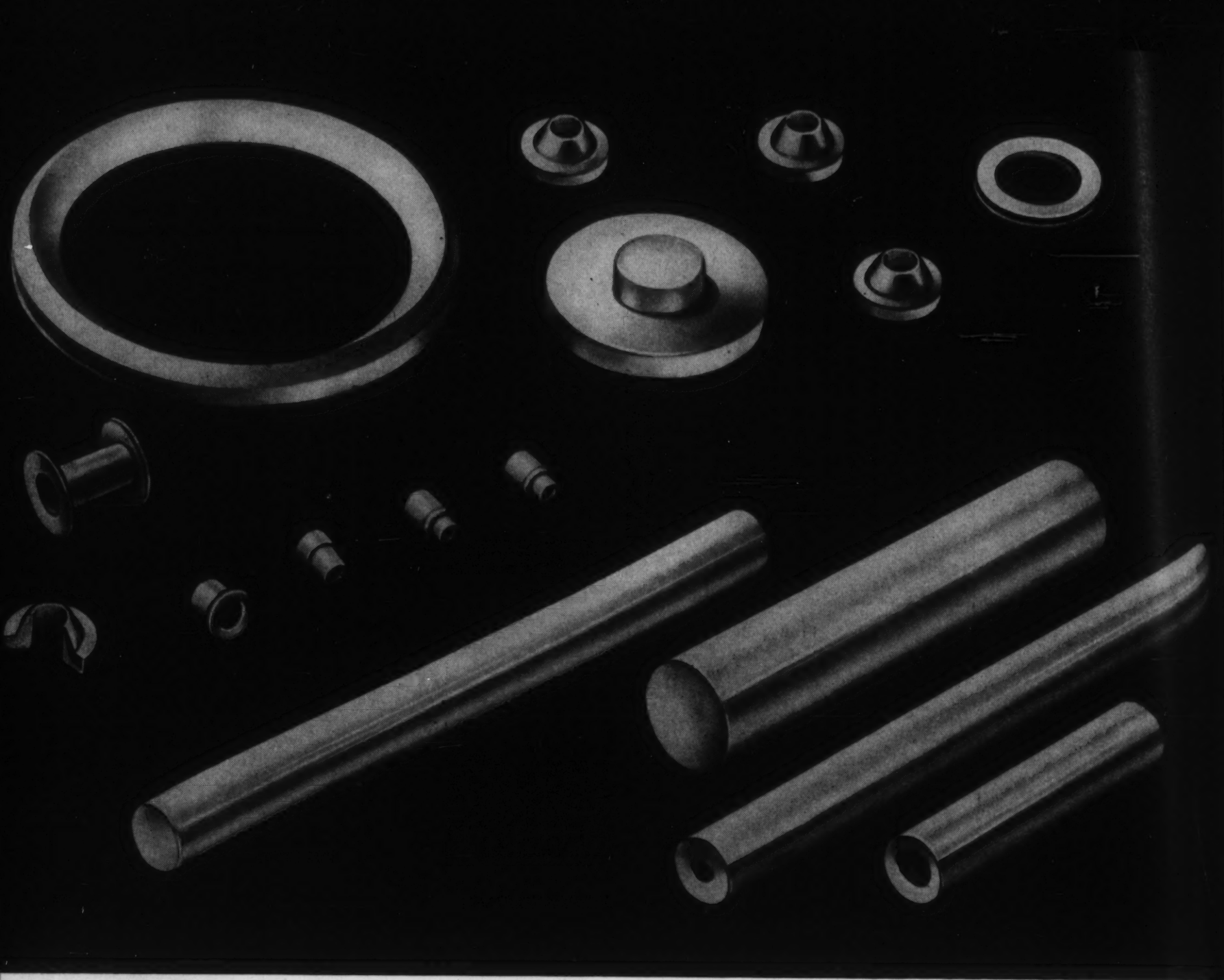
Crawler Frame Weldment Study of the heavy crawler frame of an earth-moving machine brought about a change of material and of fabricating method. The heavy piece was originally made as a steel casting, but because of the small number of foundries ready to cast pieces of this size, the supply situation was unsatisfactory. When tubular steel castings were used for bearings, and steel casting were welded to heavy plate, flame cut to shape, the frame was produced as a weldment. A weight saving and improved supply situation resulted from the change. (Courtesy R. C. Mahon Co.)

Materials in Shaving Lotion Clarification Equipment Titeflex, Inc. has designed a mechanical clarification unit to remove traces of foreign matter from Mennen Skin Bracer alcohol base shave lotion. The entire flow cycle was engineered to: (1) resist the corrosive action of a high ethyl alcohol content; (2) provide a long-lived, easy to clean, sanitary flow surface; and (3) be explosion-proof. The filter used has 40 sq ft of well-screen vertical membranes. Valves have Neoprene diaphragms. The pressure pump is constructed entirely of 316 stainless steel. The decanting pump is also constructed entirely of 316 stainless, and is equipped with Teflon fittings. The relatively high ductility and impact resistance of 316 make it a practical alloy for forming all moving parts of the pumps and flow lines. The alloy is resistant to pitting and the corrosive action of high concentrations of ethyl alchol which are present in Mennen's Skin Bracer. In general, molybdenum bearing 18:8 stainless steel Type 316 is impervious to pitting or pin hole corrosion in applications where alcohols acetic acid vapors or solutions of chlorides, bromides or iodines are encountered. In the manufacture of cosmetics and pharmaceuticals, the molybdenum alloys are usually specified in order to avoid excessive metallic contamination.

Neoprene, due to its well-known high resistivity to deterioration by ethyl alcohol, is used in the Mennen unit to prevent corrosion of filter tank walls and flow line valve diaphragms.

Teflon is used for the liner and packing of pump fittings because of its chemical inertness and resistance to corrosion and surface contamination. Here again, the material was specified for long and trouble-free use where flows of high-concentrate ethyl alcohol are involved.





COMPLEX PARTS *are machined from Teflon rod and tubing. Teflon is more difficult than Kel-F to mold directly in relatively complicated shapes.*

Fluorocarbon Plastics —What They Can Do —Where to Use Them

by **PHILIP O'KEEFE,** Associate Editor, Materials & Methods

Two types—Teflon and Kel-F—are commercially available . . . Others are on the way . . . New fabricating techniques and promises of lower price are extending their use.

● FLUOROCARBON PLASTICS, developed within the last few years, are rapidly increasing in importance as engineering materials. Prices have been lowered by the producers and new formulations are extending their usefulness. Also, new fabricating techniques are cutting finished product costs and expanding design possibilities. Heat treatments have even been developed to minimize some characteristics that were formerly disadvantageous in some uses. Some of the many new applications of fluorocarbons are being found in gaskets, packing materials, electronic insulation, non-stick materials, corrosion resistant linings, flexible bellows and diaphragms.

Two fluorocarbon plastics are being made at present by three suppliers. E. I. du Pont de Nemours & Co., Inc. markets polytetrafluoroethylene under the trade name Teflon. Polytrifluorochloroethylene is made by two companies. The M. W. Kellogg Co. tradename is Kel-F. Union Carbide and Carbon Corp. will soon

market the material under the name Fluorothene.

Teflon and Kel-F differ somewhat in properties, price and fabrication. In general, Teflon has greater chemical and heat resistance. Kel-F, on the other hand, is easier and cheaper to make into finished products, for the most part. While prices are expected to come down, Teflon powder now sells for about $5.50 a lb in the raw material state. Kel-F powder goes for $12 a lb, at present.

Properties

Fluorocarbon plastics are relatively dense plastics. Teflon is opaque, while Kel-F is translucent or transparent. Both are relatively soft and flexible. Teflon tends to cold flow under pressure somewhat more than Kel-F, which returns to its original shape better after the pressure is released. Fluorocarbon plastics are slippery to the touch, and have extremely low surface friction. They do not have the wear resistance of nylon, however.

Chemical resistance is phenomenal. Light and age have no detectable effects on fluorocarbons and water absorption is zero. Fluorocarbons withstand attack by practically all chemicals except molten alkali metals. Fluorine gas at 300 F has a slight effect on Teflon moldings. Chlorine trifluoride also attacks Teflon at elevated temperatures. Kel-F is swelled slightly by some aromatic and halogenated hydrocarbons. However, acids, alkalies, oxidizing agents and most solvents have no effect on these plastics.

Fluorocarbons have wide temperature tolerance limits. Teflon withstands temperatures from below —100 to +500 F. The softening temperature is somewhat lower than 500 F, however. Kel-F can be used up to 390 F, and down to temperatures below —100 F.

Electrical properties are also outstanding. As a low-loss dielectric material, Teflon is comparable to any known solid dielectric. Kel-F is also outstanding. The electrical properties are practically unchanged over the entire operating temperature range of the plastics. Arc resistance and volume resistivity are extremely high. The electrical loss factor is extremely low with both plastics. At high frequencies, however, the power factor of Kel-F is about six times that of Teflon. Neither material shows arc tracking.

From a properties standpoint, there have been several disadvantages to these plastics. Until recently, no adhesive bonding methods have been available for fluorocarbons. Within the last year, however, a method of preparing the surface of Teflon so that the commercial adhesives can be used with conventional bonding techniques has been announced. Bonded parts are somewhat limited in upper temperature ranges, of course. A more serious limitation is the lack of dimensional stability of the pure fluorocarbons, especially over wide temperature ranges. This is improved by compounding with other materials, but the chemical and electrical properties suffer correspondingly with the characteristics and proportion of the additives.

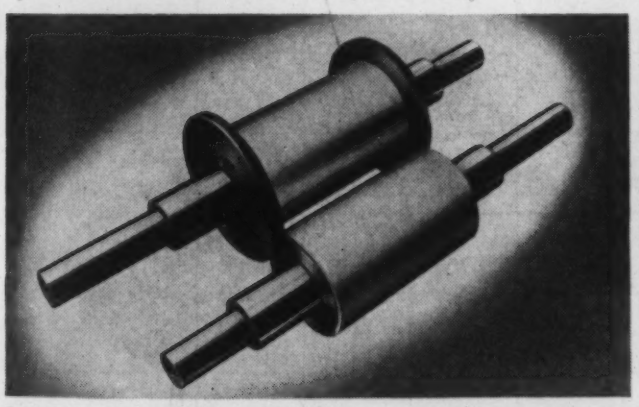
Forms and Fabrication

Fluorocarbons are available as molding powder, sheets, tubes, rods, film, tape, molded shapes, machined parts, fabric coatings, metal finishes, wire enamels and liquid dispersions.

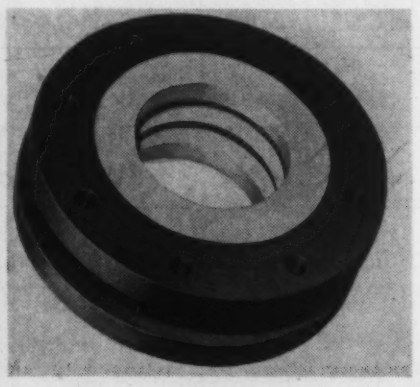
Teflon does not melt or flow and, therefore, conventional thermoplastic molding methods cannot usually be used with it. Simple shapes such as sheets, tubes, rods, angular rings and blocks are made by methods similar to those used to produce sintered powder metal parts. Teflon can be extruded by special methods, and relatively simple shapes can be made as compression moldings. Injection molding is not feasible with Teflon. Complex parts can be made by machining simple shapes, although this involves loss of a great deal of the expensive plastic. Recently, however, production molding methods for making complex parts, with deep undercuts, have been developed. These new techniques may open many new applications to Teflon.

Kel-F is easier to fabricate. Conventional extrusion, compression molding and injection molding can be used. One advantage of Kel-F is the fact that it can be used with plasticizers. These plasticizers are lower molecular weight Kel-F oils or greases. They do not deleteriously effect the chemical resistance of the finished product, but are soluble in some organic solvents. The top operating temperature of plasticized parts is lower than with the unplasticized material. Kel-F is somewhat easier to machine than Teflon since it is more rigid.

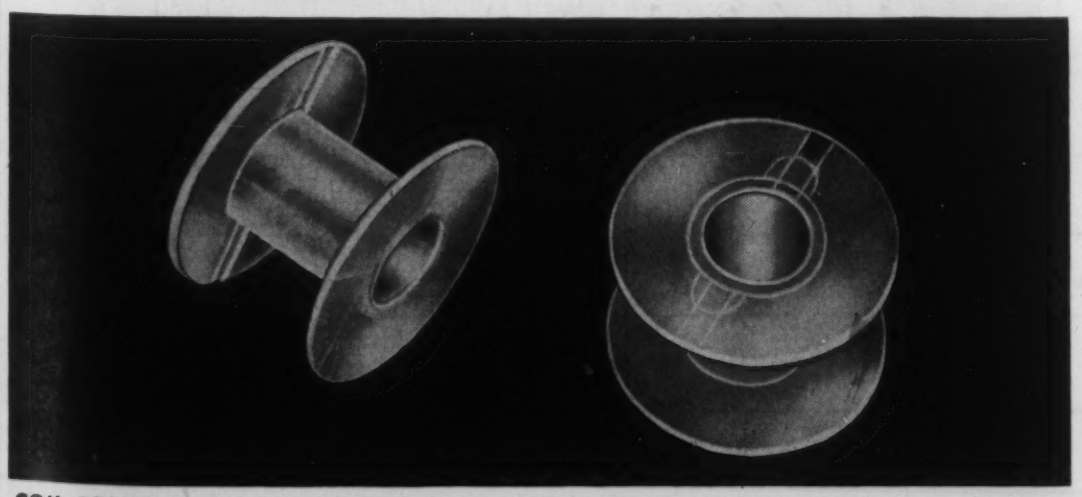
These plastics can now be combined with other materials. New adhesive bonding techniques make it possible to make metal-faced fluorocarbon parts. Hermetic seals can be made between Kel-F or Teflon and metal. Mixtures of these plastics with metal powders, ceramics, graphite and other powder materials are also coming into wide use. These parts are made by sintering techniques in the case of Teflon, while Kel-F parts are molded. The parts may be cheaper than pure Teflon or Kel-F and may have better dimensional stability.



***BAKERY DOUGH-SHEETING ROLLS** with Teflon surfaces do not require flour dusting. Scraper blades do not have to ride on these rolls and blade wear is eliminated.*



***FLEXIBLE COUPLINGS** made of Teflon resist most chemicals and provide joints between pipes of different materials.*

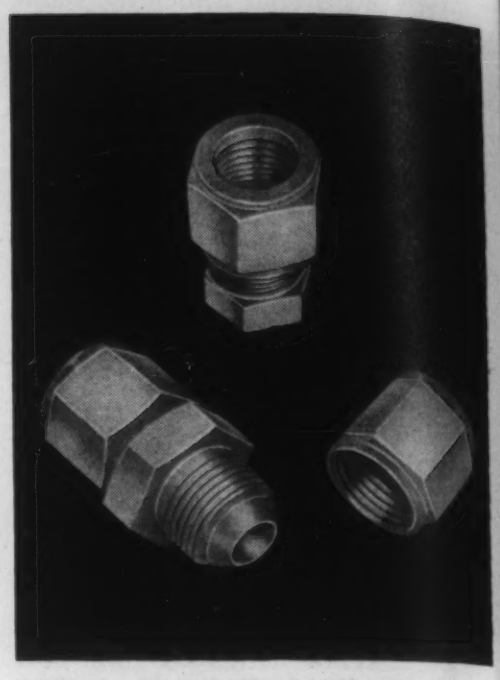


COIL FORMS *are made of Kel-F because of its resistance to heat, low heat conductance, and superior electrical properties.*

The temperature and chemical resistance of combination parts depend on the properties and the amount of the filler. The electrical properties—power factor, dielectric constant, arc resistance, etc.—can also be varied widely by the choice of filler. It is possible to make combinations with practically zero coefficient of thermal expansion, while most of the electrical properties of the fluorocarbon are retained intact.

All of these property variations can be controlled closely. The concentration of filler can be varied in different sections of a single piece. Thus, by using metal powders electrical conductivity can be varied continuously from almost absolute zero in the pure Teflon or Kel-F base of a piece, to that of a semi-conductor at the surface where the metal powder concentration is maximized. One rule to remember with combination parts is that the chemical and electrical properties cannot be improved over those of the pure plastic by any concentration of any filler.

Heat treatment is important for some parts. Many parts cut from material which was deformed too much in manufacturing returns to its original shape in service, especially at elevated temperatures, due to plastic memory. A stress relief heat treatment before cutting solves this problem. The application of heat at 300 F has the desired effect on overstressed Teflon. With Kel-F, an anneal for 24 hr at 255 F assures dimensional stability. Quenching freshly molded Kel-F through the range of 425 to 300 F is used to obtain transparency and flexibility by retarding crystallization. The crystalline Kel-F obtained by slow cooling is opaque, relatively hard and resists swelling by solvents better than the quenched material. The effects of quenching depend on the molecular weight of Kel-F and the section thickness. Sheets 1/8-in. or more thick cannot be quenched to colorless transparency due to the low heat conductivity of Kel-F. The lower the molecular weight of the plastic, the lower the transition range. Thus, a lower molecular weight Kel-F that is quenched to flexibility will crystallize fairly rapidly at 350 F and become brittle.



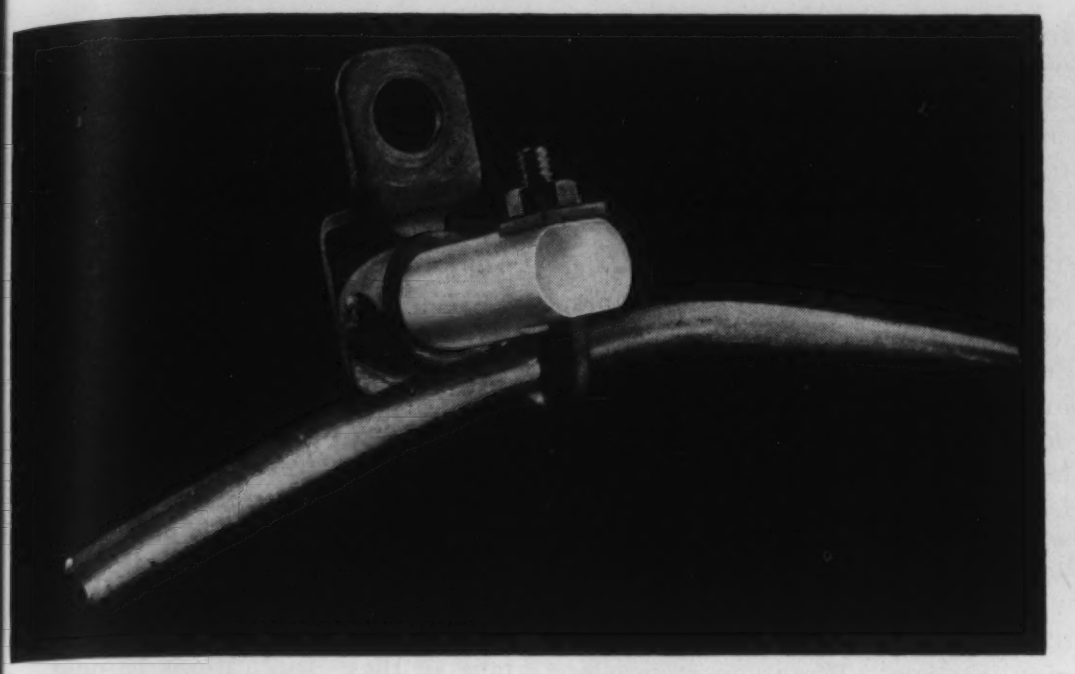
***TYPICAL MACHINED PARTS** are shown. Kel-F machines readily.*

Liquid dispersions are also used. Nonaqueous Kel-F dispersions are dipped, brushed or sprayed on metal, glass or stoneware. After drying, the coating is fused. Coatings from

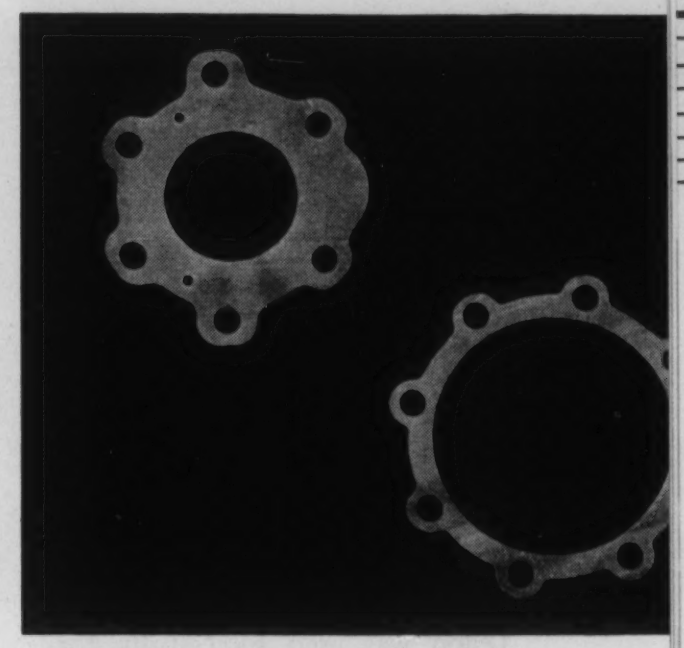
Properties of Filled Teflon

(Filler Proportions in % by Weight)

Property	ASTM Test Method	Unfilled Teflon	33% Carbon	50% Carbon	67% Carbon	25% Graphite	50% Graphite	75% Graphite	52% Asbestos	33% Talc	80% Copper	80% Zircon
Tens. Str., Psi	D638	1,800	2,375	2,300	1,790	2,200	2,425	1,990	1,780	1,700	2,300	—
Elong., %	D638	100-200	—	—	5.9	—	—	1.2	0.2	4.7	—	—
Mod. of Elasticity, Psi	D638	58,000	421,000	431,000	574,000	309,000	378,000	—	1,190,000	310,000	—	—
Flexural Str., Psi	D790	Did not break	6,100	6,200	3,980	5,700	4,560	3,200	4,080	Did not break	4,170	4,200
Compressive Str., Psi	D695	Did not break	—	—	8,650	—	5,400	5,600	—	—	2,900	—
Impact Str., Izod, Ft-Lb per In.	D256	4.0	1.78	1.45	0.8	2.14	0.86	—	0.86	—	—	—
Def. underload 2000 Lb/Sq In./°F in 24 Hr., %	D621	25	1.7	—	0.9	—	—	—	0.3	—	—	—
Hardness, Shore D	D676	55	—	—	75	—	68	70	75	65	82	90
Specific Gravity	—	2.14	2.13	2.08	1.95	2.13	2.10	2.16	2.4	2.4	5.0	3.4
Therm. Cond. BTU/Hr/Sq Ft/°F/In.	(Cenco-Fitch)	1.7	—	—	6.8	—	9.5	19.5	4.2	—	7.5	—
Electrical Resistivity, Ohm-Cm.	—	$>10^{15}$	—	—	0.0	—	87.6	0.0	2.6×10^{12}	—	2×10^{5}	—
Water Absorption, %	(2-Hr. boil)	0.0	—	0.01	0.07	0.0	0.0	0.0	0.05	0.03	—	—



UHF AERIAL SUPPORTS require the outstanding electrical properties of Kel-F.



GASKETS of thin film Kel-F are resistant to wetting by water and are unaffected by high humidity or tropical exposure. The material shows zero water absorption in standard tests.

0.005 to 0.015 in. can be built up. These coatings show properties similar to coating applied by pressing, extrusion or compression molding. Teflon is used in aqueous dispersions. These are used to make cast film, to coat glass fabric mats and laminates, to impregnate asbestos fabric and braid, to coat metals, and to form blends with fillers. Coatings are dried and fused.

Gaskets and Packing

One of the most extensive uses of Kel-F and Teflon is for gaskets and packings. Solid, tapered and V molded ring packings are used in regulating pumps, diaphragm valves, centrifugal pumps, rotary pumps, mixer shafts, bottle filling nozzles, autoclave shafts, hydraulic jacks, metering devices, oxygen valves, rotary swing joints, fluid piston rings, chemical valves, liquid ends of reciprocating pumps, expansion or slip joints, and positive displacement pump plungers. Braided, impregnated, and asbestos and plastic packings containing grease and powdered plastic are also used. Low friction, chemical and heat resistance and the absence of electrolytic action are advantages. Braided packings are made of pure fluorocarbon tape or of asbestos with the plastic for surface lubrication. Molded packings come with or without graphite impregnation.

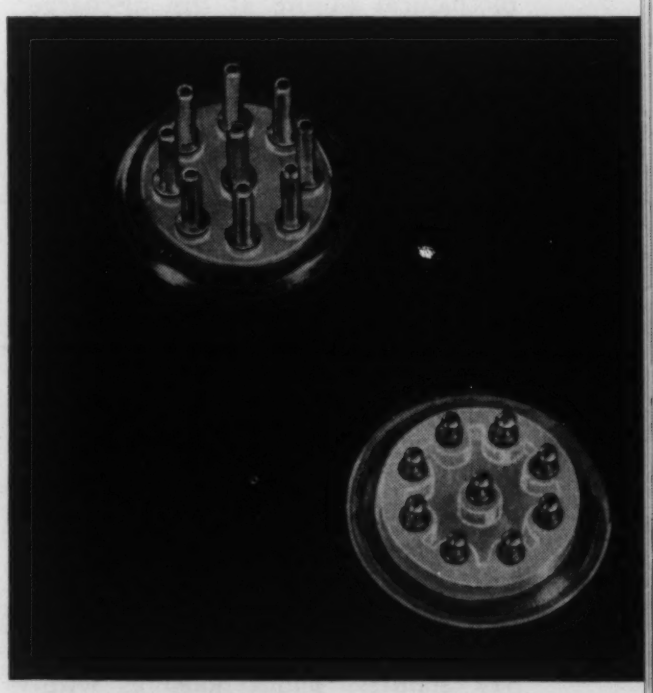
Gaskets of these materials are used where chemical resistance or noncontamination of the product is required. Solid gaskets are most common. Raised face flanges are used for 150- to 300-psi pressures. Tongue-in-groove or some other confining arrangement extends pressure limits up to 30,000 psi. Compression characteristics are similar to those of the best grade rubber-bonded compressed asbestos.

The lack of resiliency of Teflon presents a problem in applications where thermal expansion of adjacent metal parts changes the pressure on the gasket. Spring loaded flange bolts are a solution. Since the gaskets do not stick, they do not have to be changed when a joint is opened frequently.

Envelopes of the plastics are often used over Neoprene or asbestos cores. Envelope gaskets are used for glass, porcelain and glass-lined equipment where misalignment of flanges and low bolting pressures result in failure to seat solid gaskets. Spiral-wound gaskets have a plastic filler wound spirally with preformed stainless steel strip. These combine the strength of metal with the sealing ability and chemical resistance of the plastics. Asbestos gaskets impregnated with fluorocarbons are a promising recent development.

Other Chemical Applications

Teflon bellows connectors are designed for chemical pipe applications where vibration, expansion and electrolysis are problems in handling of corrosive liquids or gases and solvents. They are being used to connect chemical resistant piping and equipment made of glass, glass-lined



MULTI-LEAD TERMINALS use Kel-F, which can be compression, transfer and injection molded.

INTRICATE PARTS are production molded of Teflon by recently developed methods. Deep undercuts are molded in this aircraft pump diaphragm for corrosive fluids.

steel, carbon, porcelain, stainless steel, etc. Adapters and slip joints are eliminated, and the connectors take the place of gaskets. The bellows absorb vibration, thermal expansion and misalignments and allow for small longitudinal movements of the pipe.

Teflon plug valve liners require no lubrication for ease of movement or for seal. There is no metal-to-metal contact, and adjustment is easy. Stuffing boxes and packings are eliminated. In an application handling caustic soda and glycerin at 200 F, conventional valves leaked and corroded surrounding parts. A Teflon valve liner eliminated leakage and repacking.

Teflon was used successfully for the body of a steam jet evactor handling dilute sulfuric acid. Carbon, the material used previously, did not have sufficiently high mechanical properties and required metal supporting castings. In 3 to 6 months the carbon jet evactor failed by mechanical failure at the discharge gasket and erosive wear of the nozzel and diffuser. The Teflon unit required no metal supports and eliminated gasketing problems. Wear in the nozzel and diffuser was almost negligible. It was still in service after 18 months.

Many valve and pump parts are made of Kel-F and Teflon. Glass-filled Kel-F valve seats are one example. Kel-F valve diaphragms withstand prolonged exposure to concentrated nitric acid, sulfuric acid and hydrochloric acid, strong caustic, fuming nitric acid, aqua regia, other vigorous oxidizing agents and most organic solvents. Pump bearings and impellors have been made of Teflon, and successfully handle fluids that Type 317 stainless pump housings withstand.

Nonstick Uses

Teflon and Kel-F are being used in a variety of operations where sticky substances are handled. By using Teflon coatings at critical points, maintenance for cleaning is reduced, material waste is reduced, additives to reduce stickiness are eliminated and product quality is improved.

Teflon provides an excellent surface for bread-sheeting rolls. The wet, sticky dough is rolled out into a thin sheet by several pairs of rolls. With stainless steel rolls, it was necessary to have accurately ground scrapers and to keep the dough dusted with flour. Scrapers were reground frequently and even the rolls had to be reconditioned occasionally. Teflon coatings corrected these difficulties and improved dough quality. The rolls are made by molding a Teflon tube directly on a steel mandrel.

Another bakery application is a Teflon coating for the helix of a dough-rounder. This machine shapes the dough into a sphere. The usual design consists of a helical track mounted outside a rotating cone. The dough sticks to the track and accumulates in a few hours. Cleaning was laborious. When the helix was coated with Teflon, the need for cleaning was virtually eliminated.

Teflon has also been used as a covering on hot sealer plates of wrapping machines. Wrapping materials, such as polythene, cellophane and waxed paper, are sealed by heating the folded wrap between heated plates. At their fusion temperature, these materials are sticky. They do not separate easily from the heated plate. A Teflon covering on the plates minimizes sticking, carbon deposits and the build-up of foreign matter. It also reduces drag over the heater plate. The coating thickness varies with the application, but thicknesses over 0.030 in. reduce heat transfer too much. The attachment at one end of the covering is spring loaded to take up the thermal expansion of the Teflon.

The same plastic is also used in guides, dead plates, hoppers and folding parts of packaging machines to reduce cleaning and improve operating efficiency. Where only a thin coating is required and the shape is complicated, a Teflon finish is applied to metal. Where wear is encountered, a sheet, rod or tube of Teflon is attached by screws or other mechanical means. The same coatings are being used on calender end plates. The use of Kel-F on certain print rolls has made possible some operations not heretofore considered possible.

The nonstick properties of Teflon and Kel-F can undoubtedly be used in other places where food, rubber, chemical and petroleum products are handled. The following applications are being considered: coatings for molds for rubber, plastics and candy; lining for bread pans; end plates for paint mill rolls; covering for rolls used on paper machines and in steel pickling baths; separator sheets and platen coatings for laminating equipment; coating for drum driers; coating for doctor knives; and lining for feed hoppers.

Electrical Applications

Fluorocarbons are used extensively in wire and cable insulation. The exceptional electrical properties and moisture and heat resistance are the selling points. Teflon is valuable for conductors carrying high frequency currents because of its low power factor.

Teflon tape and sheets are used in motors, generators, transformers and coils as conductor insulation for armature and field coils, coil wrappers, slot liners, lead insulation and coil separators within slots. The toughness of Teflon allows coils to be formed to shape after taping. Glass fiber tape and braid is often used with Teflon tape in these applications to hold it in place and fully utilize the insulating properties of the plastic material.

Kel-F and Teflon are widely used for small electronic parts. The moldability of Kel-F is an advantage here. Complicated bases for many-pronged electronic tubes are injection molded of Kel-F. Other electronic uses of Kel-F include coil forms, UHF aerial supports, rotary electric switches, electronic caps, antenna bases and multilead terminal bases. At very high frequencies, however, the lower power factor of Teflon is desirable. In electronic transformer terminals, a hermetical seal is obtained between the plastic insulation and the metal inserts. Corrosion resistant electrical connectors use Teflon for the insulating base that carries the conductors inside the threaded metal caps.

Teflon spacers are designed for air dielectric insulation in coaxial cable. Air is the ideal dielectric for high frequencies. The use of Teflon spacers to hold the conductor away from the walls of an enclosing tube gives the best possible insulation for high frequencies. The spacing can be done by winding Teflon filament around the wire or by using Teflon beads or pierced disks. For insulators using cup shaped beads, there is no final wrapping.

Acknowledgments

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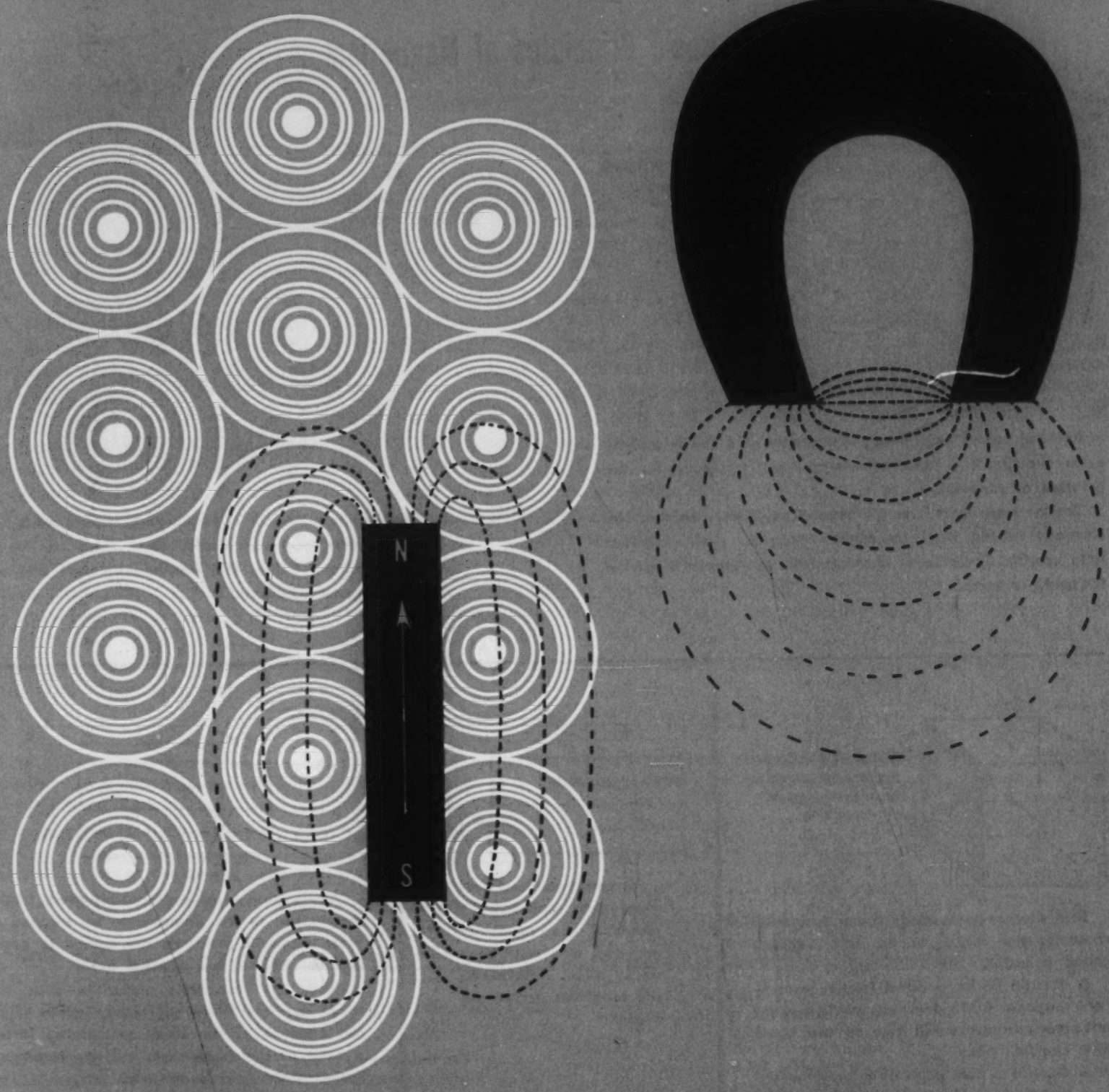
PICTURE CREDITS: *Crane Packing Co.; United States Gasket Co.; M. W. Kellogg Co.; Plastics Div., Sparta Heat-Treat Co.*



Magnetic Materials

by G. H. Stearley, Westinghouse Electric Corp.

MATERIALS & METHODS
MANUAL No. 93

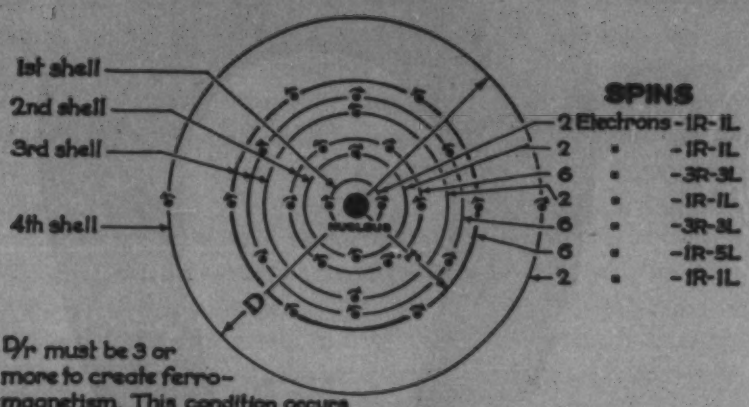
This is another in a series of comprehensive articles on engineering materials and their processing. Each is complete in itself. These special sections provide the reader with useful data on characteristics of materials or fabricated parts and on their processing and applications.

APRIL 1953

Magnetic materials are indispensable in modern industry. The functioning of communication apparatus, electric power equipment, automotive and aircraft engines and many other products depend on magnets of various types. Magnetic materials fall conveniently into four groups depending on their functions. This Manual discusses the compositions, properties, characteristics and applications of these materials under the headings

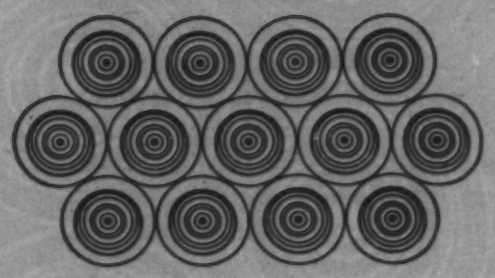
- ***Nonretentive Magnetic Materials***
- ***Permanent Magnetic Materials***
- ***Special Property Magnetic Materials***
- ***Nonmagnetic Materials***

Basic Principles of Magnetism

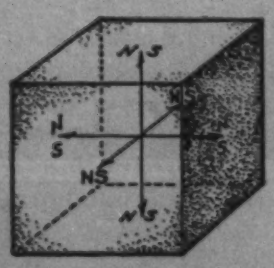


Physical concept of the inner structure of a ferromagnetic atom showing the electron arrangement necessary for the creation of magnetism.

The uncompensated, or off-balance, planetary spin of the electrons in the third incomplete quantum shell, together with specific dimensional characteristics, creates a magnetic moment, or force.



Magnetic moments in neighboring atoms are held parallel by quantum mechanical forces which can be likened to the forces holding the sun, moon, stars and earth in their relative positions.



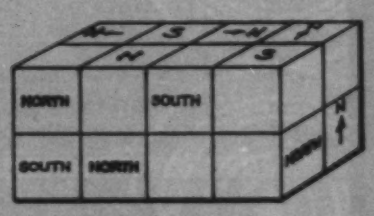
It is equally probable that magnetism will occur in any one of six directions.

The atoms possessing these magnetic characteristics are grouped into regions called domains.

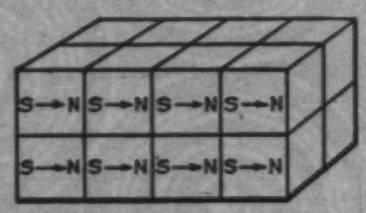
A domain is the smallest known permanent magnet. 6000 domains would occupy an area comparable in size to the head of a common pin.

A domain is composed of approximately one quadrillion (1,000,000,000,000,000) atoms.

If an atom were the size of a ½-in. ball, then a domain would contain enough of these balls to surround the earth with a band 30 miles wide.



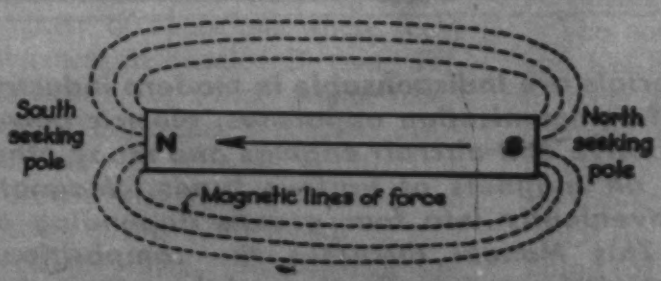
In unmagnetized ferromagnetic materials the domains are randomly oriented and neutralize each other. However, the magnetic forces are present!



Application of an external magnetic field causes magnetism in the domains to be aligned so that their magnetic moments are added to each other and to that of the applied field.

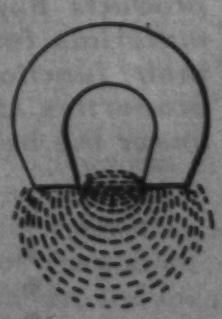
With soft magnetic materials such as iron, small external fields will cause great alignment, but because of the small restraining force, only a little of the magnetism will be retained when the external field is removed.

With hard magnetic materials such as Alnico, a greater external field must be applied to cause orientation of the domains, but most of the orientation will be retained when the field is removed, thus creating a larger permanent magnet, which will have one North and one South pole.



A freely suspended bar magnet will always tend to align itself with the North and South magnetic poles of the earth—for example, the magnetic compass.

This occurs because unlike poles of a magnet are always attracted to each other by invisible lines of force whereas like poles repel each other. The earth, of course, is the largest known permanent magnet.



Permanent magnets can be scientifically designed and made in countless shapes and sizes to perform various tasks.

The horse-shoe shape is most commonly used in magnetic separators because its lines of force are more adaptable to the tasks which must be performed in the separation of ferrous from nonferrous materials. A piece of iron placed within the effective range of a magnet will, in turn, become magnetized. It will have its own North and South poles which will be attracted to the parent, or larger magnet in proportion to its mass.

(Adapted from data compiled by Arlo F. Israelson, chief engineer, Erisz Manufacturing Co.)

Introduction

Commercial magnetic materials can be classified in four groups. These are: nonretentive or magnetically "soft" materials; permanent (retentive) or magnetically "hard" materials; magnetic materials having special properties; and "nonmagnetic" ferrous alloys.

The soft magnetic materials are those which become magnetized in the presence of a magnetic field, but are essentially demagnetized when the field is removed. Materials which belong in this group range from cast iron, which is one of the poorest, to the iron-nickel alloys, which rank among the best. Also included are cast steel, ordinary low-carbon steels, ingot iron, malleable iron and electrical (silicon) sheet steel. These materials represent an indispensable portion of modern communications apparatus and electrical power equipment. On the basis of amount used, this is the most important of the four groups.

The retentive or hard magnetic materials are those which remain "permanently" magnetized after the first application of a magnetic field. These materials find use in apparatus where a constant magnetic field is required, but where it is inconvenient to establish such a field electromagnetically. Although modern industry requires a smaller amount of hard magnetic materials than of soft material, the application of the former is the older. Ancient lore indicates that permanent magnets have been known, in one form or another, since the Chinese first fashioned a crude compass several hundreds of years B.C.

The third group consists of alloys which have properties ideally suited to special applications. This includes special temperature-permeability relationships, which can be utilized to compensate for flux changes resulting from a change in temperature. Copper-nickel alloy "shunts" and iron-nickel alloy "shunts" having the above properties are commonly used to compensate for temperature error in electrical instruments and energy-measuring devices. Other special materials include iron-cobalt alloys, which have unusually good properties at very high flux densities, and iron-nickel or iron-nickel-cobalt alloys, which are characterized by a constant permeability and low hysteresis loss

GLOSSARY OF MAGNETIC TERMS*

AGING, MAGNETIC The normal or accelerated change in magnetic properties of a magnetic material resulting from the effects of time and temperature.

COERCIVE FORCE, H_c The magnetizing force required to bring the induction to zero in a magnetic material which is in a symmetrically cyclically magnetized condition.

CURIE POINT Temperature (1450 F) above which iron is nonmagnetic.

DIAMAGNETIC MATERIAL A material having a permeability less than that of a vacuum.

DOMAINS Regions over which the axes of spinning electrons are parallel.

ENERGY-PRODUCT CURVE, MAGNETIC The curve obtained by plotting the product of the coordinates of the demagnetization curve (B_dH_d) as abscissas against the induction B_d.

FERROMAGNETIC MATERIAL A material which, in general, exhibits hysteresis phenomena, and whose permeability is dependent on the magnetizing force.

GAUSS (PLURAL GAUSSES) The c.g.s. unit of magnetic induction. (See Induction, Magnetic.)

HYSTERESIS, MAGNETIC The property of a magnetic material by virtue of which the magnetic induction for a given magnetizing force depends upon the previous conditions of magnetization.

INDUCTION, MAGNETIC (OR MAGNETIC FLUX DENSITY), B Flux per unit per area through an element of area at right angles to the direction of the flux.

INDUCTION, RESIDUAL, B_r The magnetic induction corresponding to zero magnetizing force in a magnetic material which is in a symmetrically cyclically magnetized condition.

MAGNETIZING FORCE, H Magnetomotive force per unit length. The c.g.s. unit is called the oersted and is defined by the equation:

$$H \frac{d\mathcal{F}}{dl}$$

where $\mathcal{F}$ is in gilberts and l in centimeters. For a toroid, or at the center of a long solenoid, the magnetizing force in oersteds may be calculated as follows:

$$H \frac{0.4\pi NI}{l}$$

where I is in amperes and l is in centimeters.

MAGNETOMOTIVE FORCE, $\mathcal{F}$ That which tends to produce a magnetic field. In magnetic testing it is most commonly produced by a current flowing through a coil of wire, and its magnitude is proportional to the current, and to the number of turns.

MAXWELL The c.g.s. unit of magnetic flux.

OERSTED, H The c.g.s. unit of magnetizing force.

PARAMAGNETIC MATERIAL A material having a permeability which is slightly greater than that of a vacuum, and which is approximately independent of the magnetizing force.

PERMEABILITY, NORMAL, μ The ratio of the normal induction to the corresponding magnetizing force.

PERMEANCE, P The ratio of the flux through any cross section of a tubular portion of a magnetic circuit bounded by lines of force and by two equipotential surfaces to the magnetic potential difference between two surfaces, taken within the portion under consideration.

RELUCTANCE, R The reciprocal of permeance

$$R = \frac{\mathcal{F}}{\Phi}$$

For uniform μ and A

$$R = \frac{l}{\mu A}$$

where A is area in square centimeters and l is length in centimeters

REMANENCE (OR REMANENT INDUCTION) B_d The magnetic induction which remains in a magnetic circuit after the removal of an applied magnetomotive force.

RETENTIVITY The property of a magnetic material measured by the maximum value of the residual induction.

STABILIZATION A treatment of a magnetic material designed to increase the permanency of its magnetic properties or condition.

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*Definitions from ASTM, "Standard Definitions of Terms with Symbols, Relating to Magnetic Testing", 1946, with the exception of those for Curie Point, Domains, and Energy Product Curve, Magnetic.

at low flux densities.

The fourth group is comprised of austenitic steels which have a permeability of only a few per cent more than air. However, austenitic steels do show ferromagnetic behavior in that the permeability is a function of applied field strength. Although austenitic steels are more properly included in a class which has been named "feebly-magnetic materials", the word "nonmagnetic" is used widely in commercial literature. A nonmagnetic steel having good machinability can be made at reasonable cost by alloying manganese, carbon and nickel with iron. A second type contains chromium, carbon and nickel, alloyed with iron. They are useful as construction materials where magnetic losses are important.

Nonretentive or Soft Magnetic Materials

The most important soft magnetic materials are the elements iron, nickel and cobalt, and the alloys of iron-silicon, iron-nickel and iron-cobalt. In general, alloys are more desirable than the pure metal, because the desired properties are attainable at lower cost. Commercial soft magnetic materials are given in an accompanying table.

In soft magnetic materials the desired properties are high maximum permeability, high maximum induction, low coercive force, low residual induction, and low hysteresis and eddy current losses. The factors affecting these nonretentive magnetic properties are discussed in some detail below.

Impurities

The deliberate introduction of one or more elements to a material is considered as an alloy addition. By contrast, elements which are unavoidably present in a ferromagnetic base are referred to as impurities, even though some may have beneficial effects. In general, impurities enter the crystal lattice and set up internal strains. The resulting effect of impurities on the properties of ferromagnetic materials is to decrease the permeability and increase the hysteresis loss.

The common impurities in iron are carbon, manganese, sulfur, oxygen, phosphorus and copper. Carbon lowers the saturation point, decreases the permeability, increases the coercive force and retentivity, and increases the resistivity. The hysteresis loop is broadened, and, therefore, losses are increased. These effects are more pronounced in hardened steel than in soft or annealed material. The effects of sulfur and oxygen are similar to carbon, and these elements should be reduced to the lowest attainable limits.

Phosphorus, manganese and copper have negligible effect on magnetic properties if their presence is limited to extremely small quantities. However, when the manganese content reaches about 12%, the steel becomes feebly-magnetic. Copper increases the corrosion resistance of steel, and has no harmful effect on magnetic properties if the content is kept below 0.5%.

Magnetic properties are enhanced by the presence of silicon up to about 5% or 6%. Silicon improves the aging characteristics, and reduces the core losses by increasing the electrical resistivity. However, machinability and weldability are decreased by presence of silicon. Silicon and aluminum are also beneficial in combining with oxygen which may exist as an impurity, and in this manner they indirectly increase the

Applications of Thin Electrical Steels

Thicknesses of 7, 5 and 4 Mils
(Frequencies of 400 to 2000 Cycles)

400 Cycle Motors
- Automatic Pilots and Stabilizers
- Servo-Mechanism Motors

400 Cycle Converters

Television (5 Mils)
- Deflection Yoke Cores
- Fly-Back or Horizontal-Sweep Transformers
- Vertical-Sweep Transformers

Magnetic Amplifiers
(Including Seismographs and Magnetometers)

Other Electronic Devices
- 400 Cycle Power Transformers
- Plate and Filament Transformers
- Filter Chokes
- Swinging Chokes
- Charging Reactors
- Timing Pulse Generators

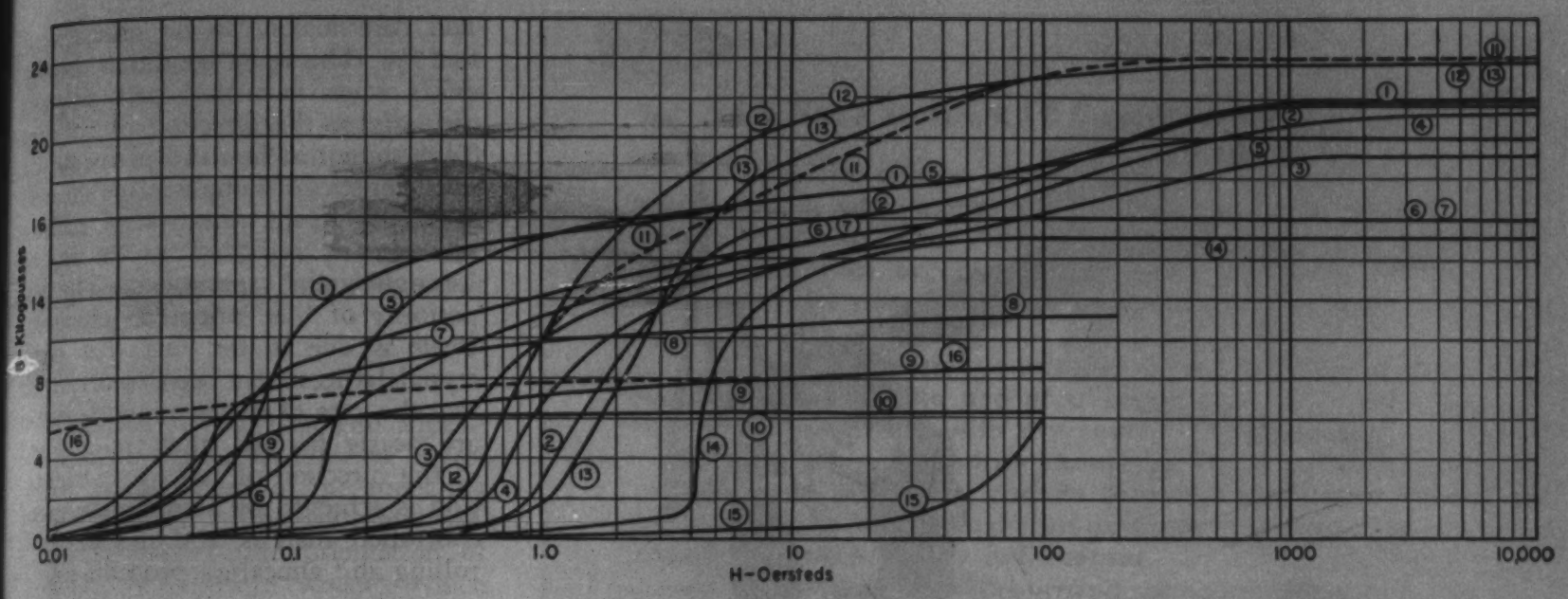
Radio
- Audio-Frequency Filters
- Voice Frequency Modulators

Thicknesses of 2 and 1 Mil
(Frequencies of 2000 cycles and higher)

- Pulse Transformers
- High-Repetition Rate Charging Reactors
- Intermediate Frequency Transformers
- Blocking Oscillator-Type Pulse Transformers
- Timing Pulse Generators
- Impulse Storing and Memory Devices (And other devices which require a high rate of change in flux with respect to time.)

Magnetic Amplifiers (Where small time-constants are required with a rather low power input.)

(Courtesy Armco Steel Corp.)



Magnetization Curves for Soft Magnetic Substances

(Data from Stanley)

The initial and maximum permeabilities are quite useful when a comparison of magnetic materials is made. (The initial permeability is defined as the slope of the B-H curve at H=O.)

Examination of the equations below shows that core loss P_c is a combination of hysteresis loss P_h and eddy current loss P_e. It can be seen readily that if losses are to be kept low, thickness of strip and area of hysteresis loop must be small, and electrical resistivity must be high.

$$P_c = P_h + P_e = K' AfB^n + K'' \frac{f^2B^2t^2}{\rho}$$

where B is the tip induction of the loop
A is the area of the hysteresis loop (corresponding to a tip induction of B)
f is the frequency
n is the exponent (less than 2)
t is the thickness of strip
ρ is electrical resistivity
K′ and K″ are constants

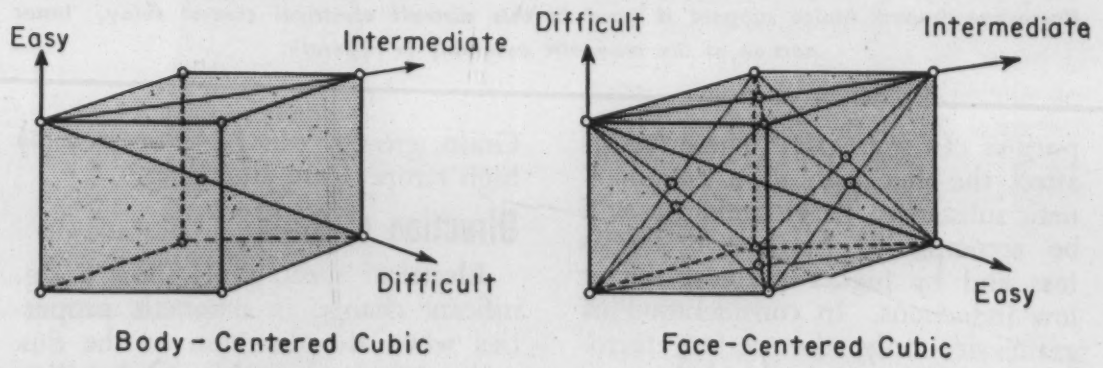
Material (Alloy)	Nominal Composition —%
1. Puron	99.99 Fe
2. Armco	99.9 Fe
3. High Si	4-5 Si, Fe Rem
4. Low Si	1 Si, Fe Rem
5. Hipersil	3.25 Si, Fe Rem
6. Nicalloy	47 Ni, Fe Rem
7. Hipernik	50 Ni, Fe Rem
8. Permalloy	78.5 Ni, Fe Rem
9. 4 Mo Permalloy	4 Mo, 79 Ni, Fe Rem
10. "1040"	72 Ni, 14 Cu, 3 Mo, Fe Rem
11. Hiperco 35	35 Co, Fe Rem
12. Hiperco 50	50 Co, Fe Rem
13. Permendur	50 Co, Fe Rem
14. Perminvar	25 Co, 45 Ni, Fe Rem
15. Iosperm	40 Ni, Fe Rem
16. Supermalloy	5 Mo, 79 Ni, Fe Rem
16. Mu-Metal	5 Cu, 74 Ni, Fe Rem

permeability.

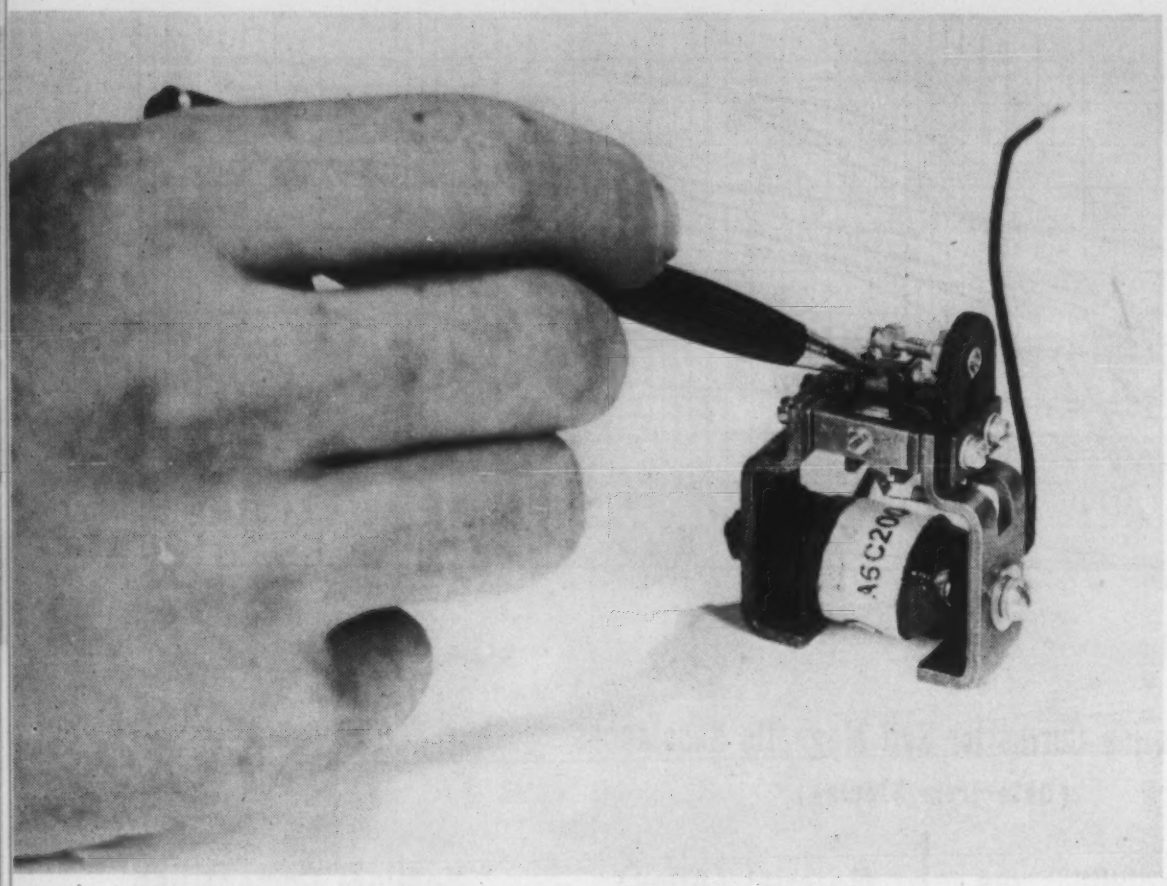
Cobalt is the only element which can be added to increase the permeability of high-purity iron in the high induction range. Pure iron would be an almost perfect magnetic material if it were not for the high eddy current losses which occur.

Grain Size

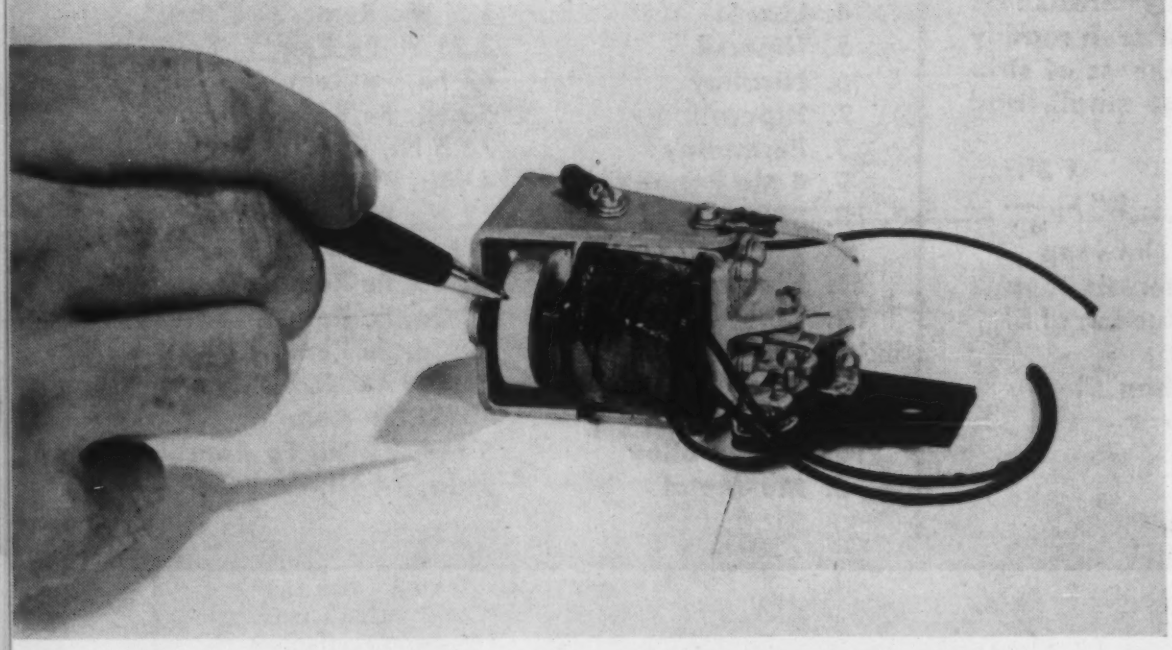
In pure metals, the grain boundaries are sources of lattice disregistry, and hence some strain will exist at these locations. Therefore, in impure materials, the grain boundaries represent regions where im-



Physical concept of crystal structures. Iron belongs to the body-centered system, nickel to the face-centered. Arrows indicate crystallographic axes corresponding to difficult, intermediate and easy directions of magnetization. Important magnetic materials belong to these two systems.



The armature of this small sensitive relay consists of an Alnico magnet pivoted between soft iron pole faces. Ingot iron is used in other parts of the magnetic circuit.



Horseshoe-shaped Alnico magnet is used in this aircraft electrical control relay. Inner portion of the magnetic assembly is Hipernik.

purities can segregate. These factors affect the flux path in a ferromagnetic substance. Large grain size will be accompanied by low hysteresis loss and by higher permeability at low inductions. In consideration of grain size only, the perfect ferromagnetic substance would be one consisting of a single crystal, magnetized in the "easy" direction. Obviously this is impractical, and the only alternative is to make the grains as large as is economically possible. Grain growth can be promoted by high temperature annealing.

Direction of Grain

Electrical sheet steels show a significant change in magnetic properties when the direction of the flux path with respect to the final rolling operation is changed. If the strips are cut so that the flux path is nearly parallel to the direction of final rolling, the permeability can be increased by as much as 20 to 30%, and core losses can be reduced 10 to 15%. The worst condition usually exists when flux must pass perpendicularly to the direction of rolling. Tests show that loss and permeability characteristics of sample strips sheared at 45 deg to the direction of rolling are almost as good as those of "straight-grain" specimens. The superiority of the "oriented" electrical steels is due to the fact that their crystal lattices have been so arranged that the axes of easiest magnetization are nearly parallel and are aligned in the direction of rolling. Orientation is achieved by a combination of controlled analysis, and special cold-rolling and annealing procedures.

Strain

Distortion arises from two different sources: (1) external mechanical stresses, and (2) internal atomic strains.

Mechanical stresses are most often set up by cold-working operations on the iron or steel. Strains beyond the elastic limit lower the permeability and increase the hysteresis loss. The effect is roughly proportional to the amount of strain, and usually the best magnetic materials are the most sensitive to abuse. High permeability alloys are very sensitive to shock and mechanical handling.

Internal strains on an atomic scale may be due to two causes—impurities and magnetostriction. The bulk of magnetic materials have crystal lattices of either the body-centered-cubic or face-centered-cubic type, and any phenomenon which distorts the lattice will disturb the magnetic properties. The effects of various impurities have already been mentioned. Magnetostriction refers to the change in dimensions of a ferromagnetic substance when it is placed in a magnetic field. A complete discussion of the magnetostrictive effect is beyond the scope of this Manual.

Temperature

Up to about 1450 F (Curie point) iron is magnetic; above this temperature it is nonmagnetic. Under moderate magnetizing forces, the permeability increases slightly in the lower range of rising temperatures, then it decreases rapidly toward the critical point. In general, ordinary temperature changes have negligible effect on the magnetic properties of iron; however, the properties are seriously impaired at temperatures above 930 F.

Iron subjected to elevated temperatures for long periods of time may develop magnetic fatigue. This is known as "aging", and is characterized by decreased permeability and increased hysteresis loss. Aging can be reduced by the addition of silicon as an alloying element and by decreasing the carbon and sulfur content.

Heat Treatment

Proper heat treatment and annealing cycles markedly improve ferromagnetism. Object of the annealing process may be to remove impurities, establish a preferred orientation of domains, or relieve stresses which have been set up by fabrication and handling. The second of the above is closely related to original rolling-mill operations; the first and third are commonly carried out on customers' premises.

Impurities such as carbon, sulfur, oxygen and nitrogen can be removed by annealing at relatively high temperatures in the presence of a reducing atmosphere. Dry hydrogen is often used.

STRESS-RELIEVING ANNEAL

1. Load the charge compactly on the annealing plate, preferably in such a manner that heat radiated from the furnace walls or cover can strike the edge of a portion of each lamination or core. Heating of the center of the charge will be retarded if the heat must first pass through adjacent piles.

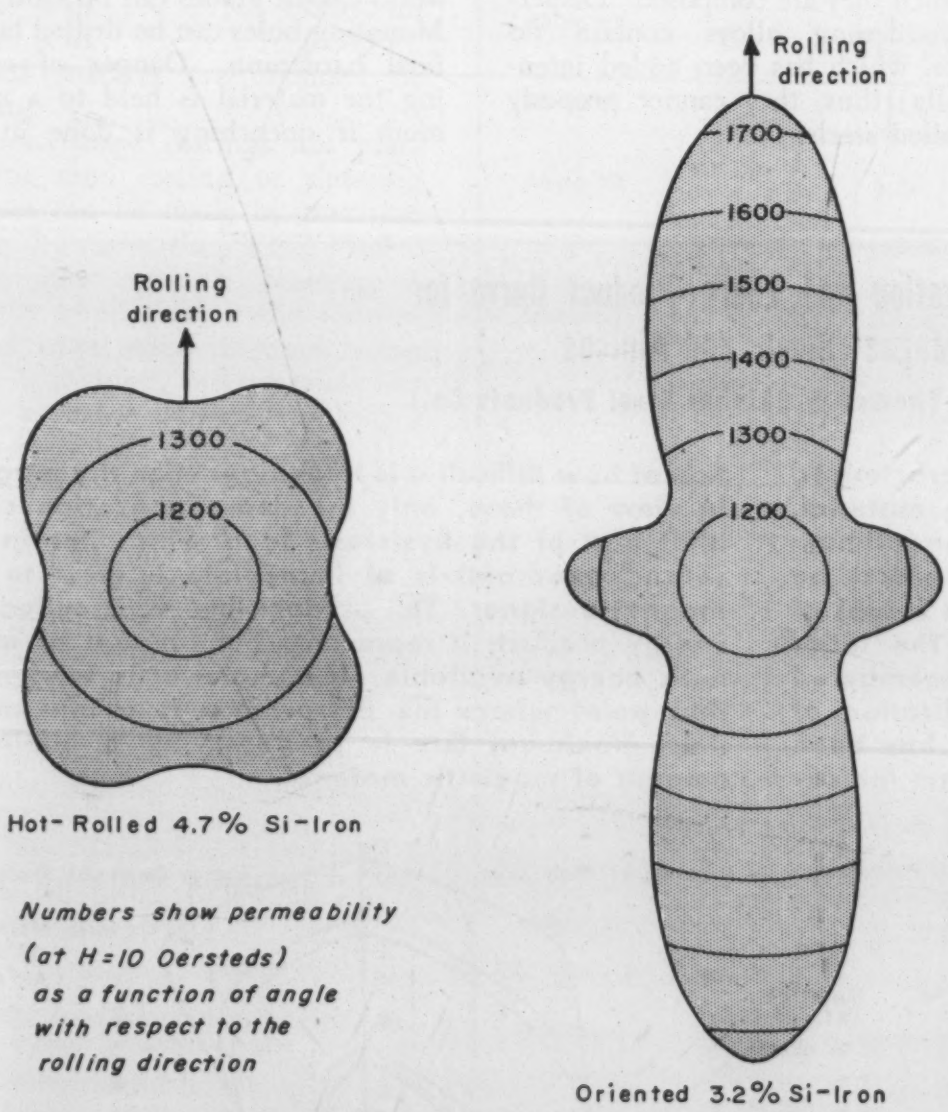
2. Avoid excessive oxidation or other damage from furnace gases by the use of a suitable cover, which can be sealed effectively with dry sand.

3. The annealing plate should be flat. Both plate and cover should be of low carbon content. The charge must be free of oil. Avoid cast iron equipment because carbon contamination is highly detrimental.

4. A neutral, noncarburizing atmosphere under the annealing cover is best. Annealing in other than a neutral atmosphere may impair magnetic qualities. Fit the annealing cover closely; see that the charge reasonably fills the bos, and flush out the original air.

5. The charge should be brought to a temperature not exceeding 1475 F, with heating and cooling rates such that distortion is avoided.

(Data from pamphlet, "ARMCO Oriented Electrical Steels," American Rolling Mill Co., 1947.)



Comparison of permeability for ordinary hot-rolled and cold-rolled (oriented) silicon iron. In iron and iron-rich alloys preferred orientation, resulting from rolling, is best utilized by taking the flux path parallel or nearly parallel to the final rolling direction.

The annealing of some ferromagnetic substances in the presence of a magnetic field results in higher permeability, due to a favorable domain orientation. The optimum process for achieving this orientation is to heat the material above the Curie temperature, then apply the magnetic field just before the Curie temperature is reached on cooling. This process relieves internal stresses due to magnetostriction and, upon cooling to room temperature, the domains will be oriented along the direction of the field.

Stress-relieving anneals involve heating the material to a suitable temperature, holding at this temperature for a short time, then cooling slowly. Type and size of material being annealed, special properties desired, and application of annealed piece must all be considered in selecting the proper time-temperature cycle.

Applications

A. C. Applications — Depending upon specific requirements, the magnetic circuits of a.c. machinery and a.c. components are made of hot-rolled electrical steels, cold-rolled oriented electrical steels, or cold-rolled thin electrical steels.

Because of their low loss and high permeability in the rolling direction, the oriented electrical (silicon) steels are particularly suitable for power transformer cores.

General applications of soft magnetic materials are given in a table. Specific applications of thin electrical steels are also tabulated.

D. C. Applications—The bulk of these applications involve some form of magnetic ingot iron.

Ingot iron is used widely in d.c. devices because of its high saturation value, good demagnetization characteristics, high density and conductivity, and consistent uniformity. Its conductivity of approximately 16% makes ingot iron suitable for third-rail applications in the transportation industry.

Magnetic core applications include control devices, relay parts, electromagnet casings, cores and armatures, magnetic chucks, loudspeaker parts, clutch plates and cyclotron electromagnet cores.

Permanent or Hard Magnetic Materials

The properties desired in a permanent magnet are the direct opposite of those considered essential for soft magnetic materials.

Although permanent magnets can be made from almost any kind of steel which can be hardened by heat treatment, it is best to use materials specially produced for this purpose. Use of other materials is most likely to result in inferior quality or unnecessary expense. At one time plain high-carbon tool steel was used for permanent magnets; however, that practice now has given away to the use of more recently developed special steels.

High-grade permanent magnetic materials are either quench-hardening steels of high alloy content, or carbon-free alloys of the dispersion-hardening type. The quench-hardening steels are hardened by rapid cooling from a high temperature by quenching in a suitable medium such as oil or water. Dispersion-hardening alloys are so called because the hardening procedure causes a dispersion of one of the two phases of which they are composed. Dispersion-hardening alloys contain no carbon which has been added intentionally; thus, they cannot properly be called steels.

Types of Hard Magnetic Materials

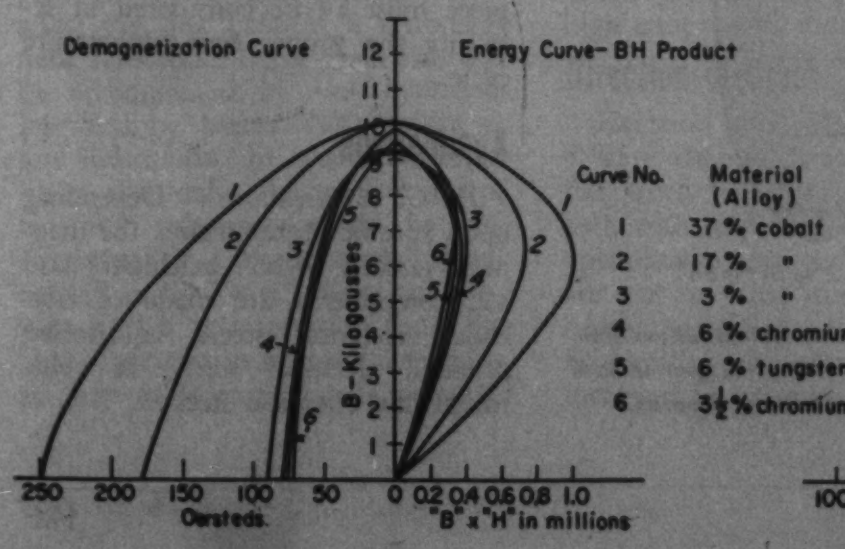
In this Manual the retentive magnetic substances discussed will be divided into three groups: magnet steels, alnicos, and special-property alloys.

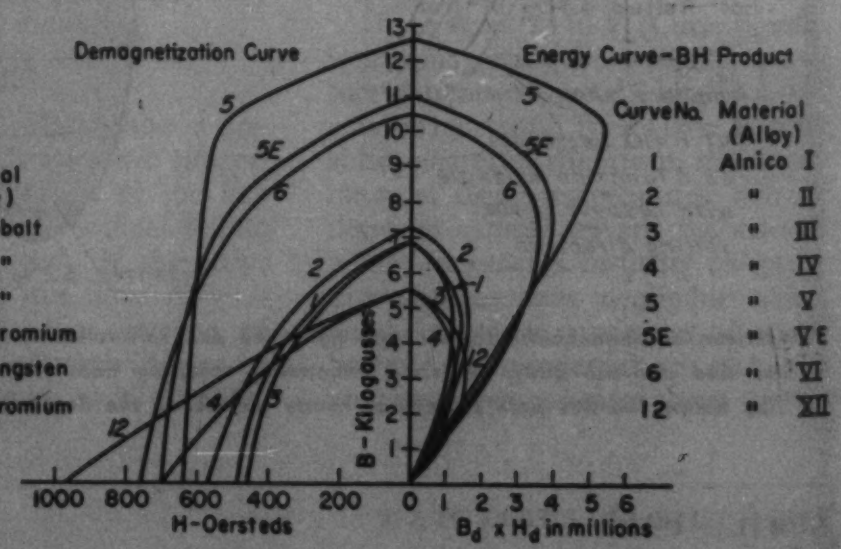
Magnet Steels—The magnet steels belong to the quench-hardening group. These steels can be formed, forged or punched hot, or they can be annealed for machining and cold work. Cobalt grades can be sand cast. Mounting holes can be drilled before final hardening. Danger of cracking the material is held to a minimum if quenching is done in oil.

Demagnetization and Energy-Product Curve for Magnet Steels and Alnicos

(Data from Thomas & Skinner Steel Products Co.)

Permanent magnet materials are characterized by a severely-strained lattice, fine grain material, high hardness, and high alloy content. For optimum retentive properties the hysteresis loop must be large, and the material must possess high values of residual induction and coercive force. The latter fact is better appreciated when it is remembered that residual induction B_r gives an indication of "how magnetic" a substance is after it has been magnetized, and coercive force H_c gives an indication of how difficult it is to demagnetize the magnet. In view of these, only the demagnetization curve (that part of the hysteresis loop which lies in the second quadrant) is of immediate interest to the magnet designer. The product, B x H, is called the energy product; it represents the amount of magnetic energy available. If a material is worked at that point where the BH product is a maximum, then maximum flux is produced by a minimum amount of magnetic material.





Where superiority of newer alloys is not required, the magnet steels are used widely because they cost less and are easier to fabricate than the Alnicos.

Typical analyses and properties of some of the steels are tabulated. Demagnetization curves and energy-product curves are given in an accompanying figure.

Alnicos—The Alnicos are dispersion-hardened alloys, consisting basically of aluminum, nickel and iron, with some cobalt, copper or titanium added. These alloys are all hard and brittle. They are fabricated by casting and grinding. Holes that are required are cored in the casting. It is also practical to introduce inserts of mild steel at the time of casting. These can be drilled or tapped after final heat treatment. Inasmuch as Alnico has a low hot-tear strength and a high shrinkage from the molten state, the section about an insert must be adequate to prevent excessive cracking.

As-cast tolerances for sand cast magnets are:

Dimensions up to 1 in... ±0.015 in.
1 in. to 4 in..... ±0.032 in.
4 in. to 6 in..... ±0.045 in.

Finished surfaces are obtained by grinding.

Intricate-shape castings not practical for sand casting or sintering processes can be made by precision casting; however, the cost is greater than by other methods. Sintering is especially applicable in the fabrication of small magnets. Tolerances can be held closer, and material costs are not as important in sintered magnets as in cast magnets.

An accompanying table gives typical analyses and some properties of the Alnicos. Curves for these materials are shown also.

Special-Property Alloys — Alloys which have been developed for special applications are listed in a table. Several of these have the added advantage of being ductile and malleable, making them suitable for small intricate-shape magnets.

Factors Affecting Retentive Magnetic Properties

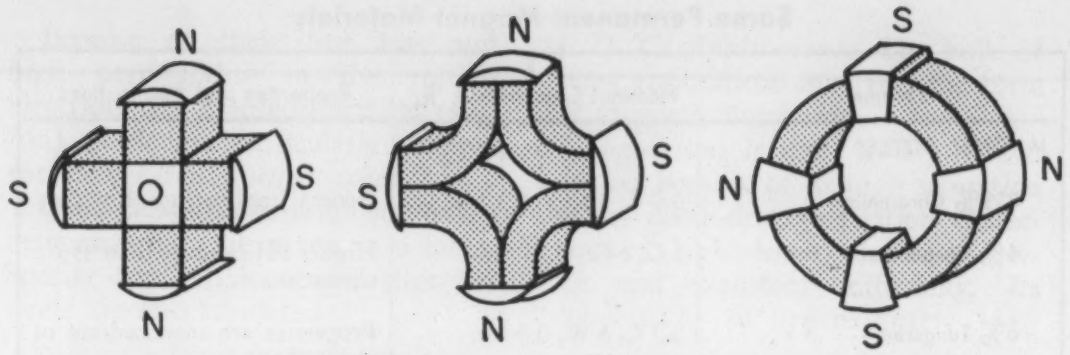
Magnetization or "Charging"—In order to obtain optimum performance from a permanent magnet, three points should be observed: (a) the magnet must be fully magnetized to saturation, (b) direction of magnetizing field should be essentially the same as that desired in final as-

Some Permanent Magnet Materials

Name	Nominal Composition, %	Properties and Applications
MAGNET STEELS*		
3½% Chromium	0.9 C, 3.5 Cr, 0.3 Mn	General applications; low cost.
6% Chromium	1 C, 6 Cr, 0.35 Mn	Higher BH product than 3½% chromium.
6% Tungsten	0.7 C, 6 W, 0.3 Mn	Properties are intermediate of those above.
3% Cobalt	0.9 C, 3.5 Cr, 3 Co, 0.3 Mn	Higher BH product than Cr or W steels.
17% Cobalt	0.8 C, 0.4 Mn, 2.5 Cr, 8 W, 17 Co	Higher BH product and coercive force than 3% Co steel.
37% Cobalt	0.9 C, 0.3 Mn, 3.5 Cr, 5W, 37 Co	Highest BH product and coercive force of all magnet steels.
ALNICOS*		
Alnico I	12 Al, 21 Ni, 5 Co	Suitable for wide range of applications.
Alnico II	10 Al, 17 Ni, 12 Co, 6 Cu	Highest BH product.
Alnico III	12 Al, 25 Ni	Can be cut and ground without chipping; costs less than 37% cobalt steel.
Alnico IV	12 Al, 28 Ni, 5 Co	High coercive force.
Alnico V	8 Al, 14 Ni, 24 Co, 3 Cu	Oriented alloy; has highest BH product of any known alloy.
Alnico VE	(Similar to Alnico V, but has some Ti)	Oriented alloy; higher coercive, lower residual than Alnico V.
Alnico VI	(Similar to Alnico VE, but has more Ti)	Oriented alloy; higher coercive, lower residual than Alnico VE.
Alnico XII	6 Al, 18 Ni, 35 Co, 8 Ti	Has highest coercive force of any Alnico.
SPECIAL PROPERTY ALLOYS		
Silmanal	86 Ag, 5 Al, 9 Mn	Ductile alloy; very low residual, very high coercive; extremely high intrinsic coercive makes it useful where length of magnet must be short as compared with its area.
Cunife	60 Cu, 20 Ni, 20 Fe	Very ductile and machinable; must be cold-worked to develop magnetic properties; easy to fabricate; cost is high.
Cunico	50 Cu, 21 Ni, 29 Co	Ductile and machinable; BH product is about one-half that of Cunife; nondirectional properties hold good for all sizes and shapes.
Vectolite	30 Fe_2O_3, 40 Fe_3O_4, 26 Co_2O_3	Made of sintered oxides; light weight, high resistivity; higher coercive force than any other alloy except Alnico XII.
Vicalloy I	38.5 Fe, 52 Co, 9.5 V	Machinable and fairly ductile, but ductility is destroyed by final heat treatment.
Vicalloy II	35 Fe, 52 Co, 13 V	Has directional properties; must be cold-worked to attain highest qualities; BH product decreases as size of piece increases.

**Balance iron.*

(Data from "Permanent Magnets", published by Thomas & Skinner Steel Products Co.)



Magnet assemblies for permanent magnet generator fields. Cost of intricate-shaped magnetic structures can often be reduced by fabricating the assembly from soft steel plus simple-shaped permanent magnets.

sembly, and (c) magnetization of magnet *after* assembly with associated parts of the iron circuit is often preferable.

Failure to fully saturate the magnet at the time of charging results in low residual induction and low coercive force. Recommended values of magnetomotive force vary from about 600 amp-turns per in. for chromium and tungsten grades, to 8000 amp-turns per in. for Alnico XII.

If direction of original magnetization is correct, no energy will be required to reorient the field when the magnet is placed in service.

Magnetization after assembly eliminates the possibility that final flux will be too low; however, consideration must be given to stabilization in this case.

Aging—During the period immediately following hardening, the magnetization curve shifts in such a way that B_r increases slightly and H_c decreases slightly. It has been found that if a magnet is charged immediately after hardening, it gradually loses some of its strength, but can be remagnetized to recover strength equal to or in some cases greater than its initial value. Aging is due to metallurgical changes within the steel. In general, it is best to allow a period of time to elapse between hardening and use of the magnet. The length of this period will depend on the degree of stability required. Aging can be accelerated by boiling the magnet in water. It should be noted that none of the grades of Alnico age to any appreciable extent

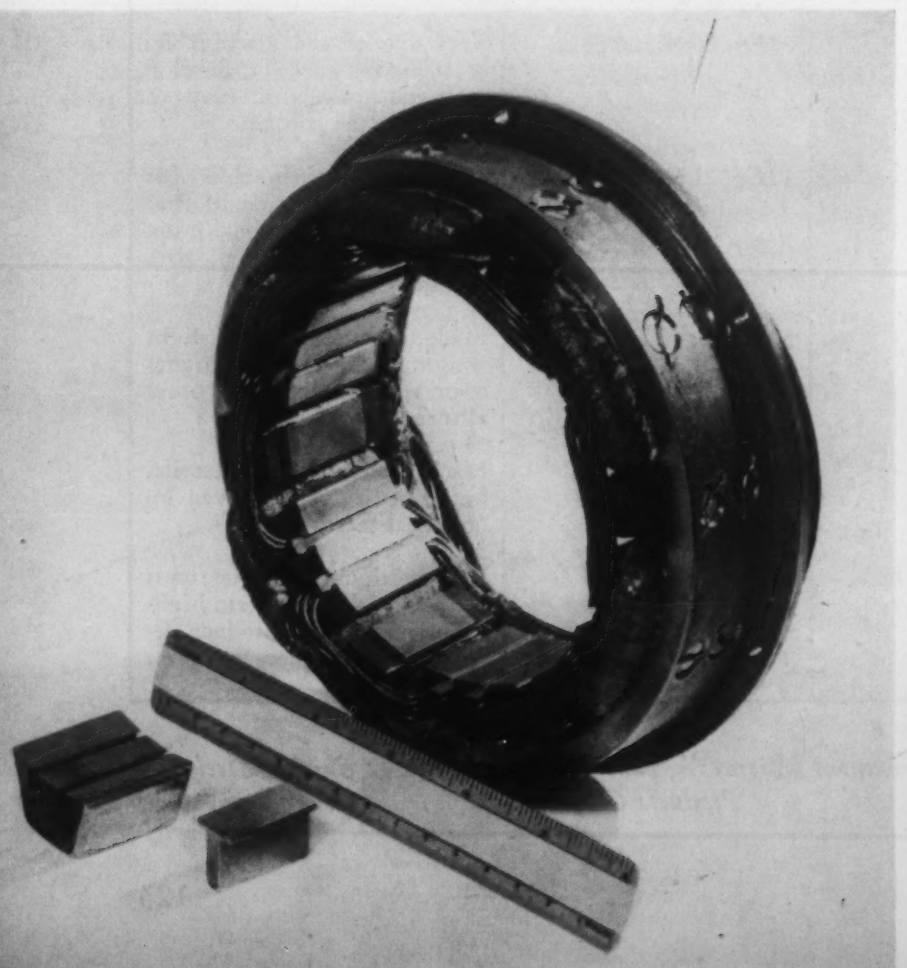
Stabilization — Three important factors which tend to demagnetize permanent magnets are the effects of stray fields, heat and vibration.

Stabilization against stray fields can be accomplished by subjecting the magnet to an alternating field whose peak value is equal to the maximum demagnetizing field which the magnet will encounter in use. If a "keeper" is placed across the poles of a U magnet while it is not in use, protection against stray fields will be provided. The keeper will also protect the magnet from the demagnetizing effects of any ferromagnetic materials which might come in contact with the magnet at points other than the pole faces.

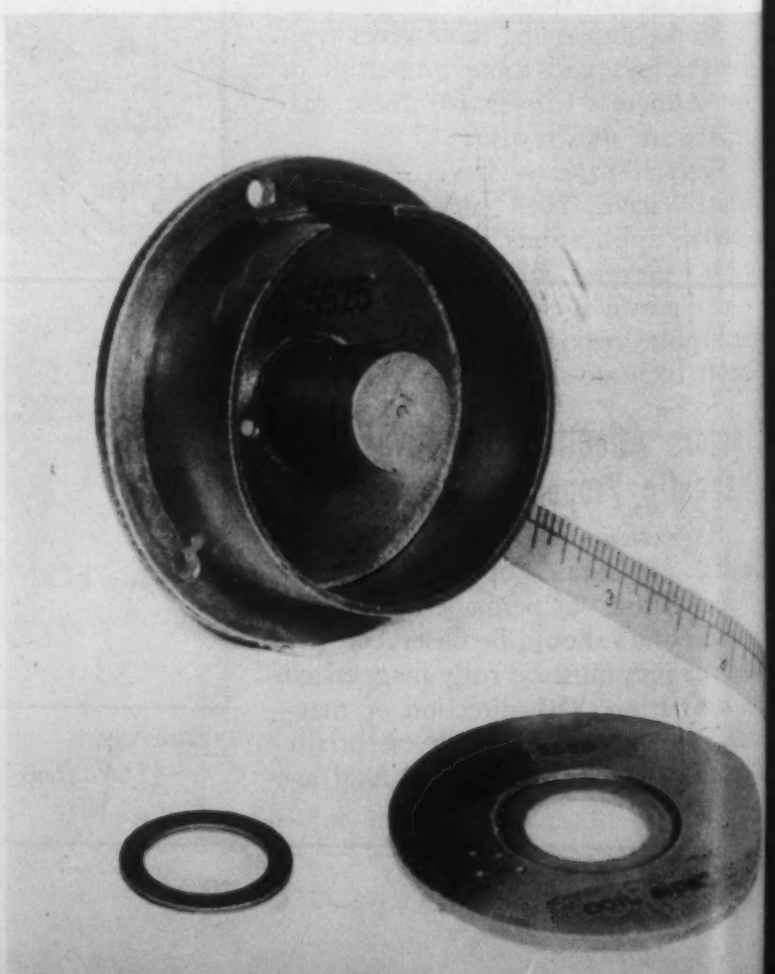
Loss of magnet flux at high temperatures is appreciable; however, upon return to room temperature, approximately half of the loss is recovered. After several temperature cycles, the strength at any given temperature within the limits is reproducible. The Alnico magnets are suitable for temperatures approaching 750 F, but the steel grades are unsatisfactory at temperatures much over 212 F.

Stabilization against vibration and

Stator of a small d.c. generator. Outer frame and small interpoles (one in foreground) are made of ingot iron. Low-silicon steel is used in the laminated main poles such as that one at the left.



Magnetic circuit which encases the operating coil for a typical carbon pile voltage regulator. The end plate contains a small ring insert (one is shown at left) made from a special composition of nickel and iron. This temperature-sensitive alloy compensates the magnetic circuit. Other parts of the assembly are made from ingot iron.



shock can be achieved by subjecting the magnet to repeated impacts until the value of flux produced has leveled off. The Alnicos are almost unaffected by vibration and shock. In the case of cobalt and tungsten steels, the per cent magnetization retained levels off after approximately 500 impacts.

Applications

Basic problems in the design of a magnet for a given application are (a) arriving at a suitable magnetic circuit wherein the required flux density is available in the air gap, (b) choice of magnetic alloy, and (c) proportioning the magnet so that the smallest amount of material is needed to produce the desired flux. Perhaps the most difficult part of accurate design is the determination of the leakage coefficient. A general method consists of estimating the permeance of all leakage paths compared to the useful permeance of the gap.

In designing the circuit, it is important that the significance of the soft-iron parts not be overlooked. These parts can be more easily fabricated than the hard magnetic materials. Although the soft-iron portions must have adequate cross-section so that their reluctance is negligible as compared to the gap, it may be possible to use them for the complex-shape parts of the circuit. Thus, an intricate magnetic circuit may be made at a lower cost from simple-shape permanent magnets.

Permanent magnets have advantages that make them desirable for many jobs. Among the advantages are availability of a constant supply of energy, independence from external power sources, and complete portability.

Commercial uses of permanent magnets fall into three broad groups whose functions are transformation of mechanical energy to electrical energy, transformation of electrical energy to mechanical energy, or tractive effort.

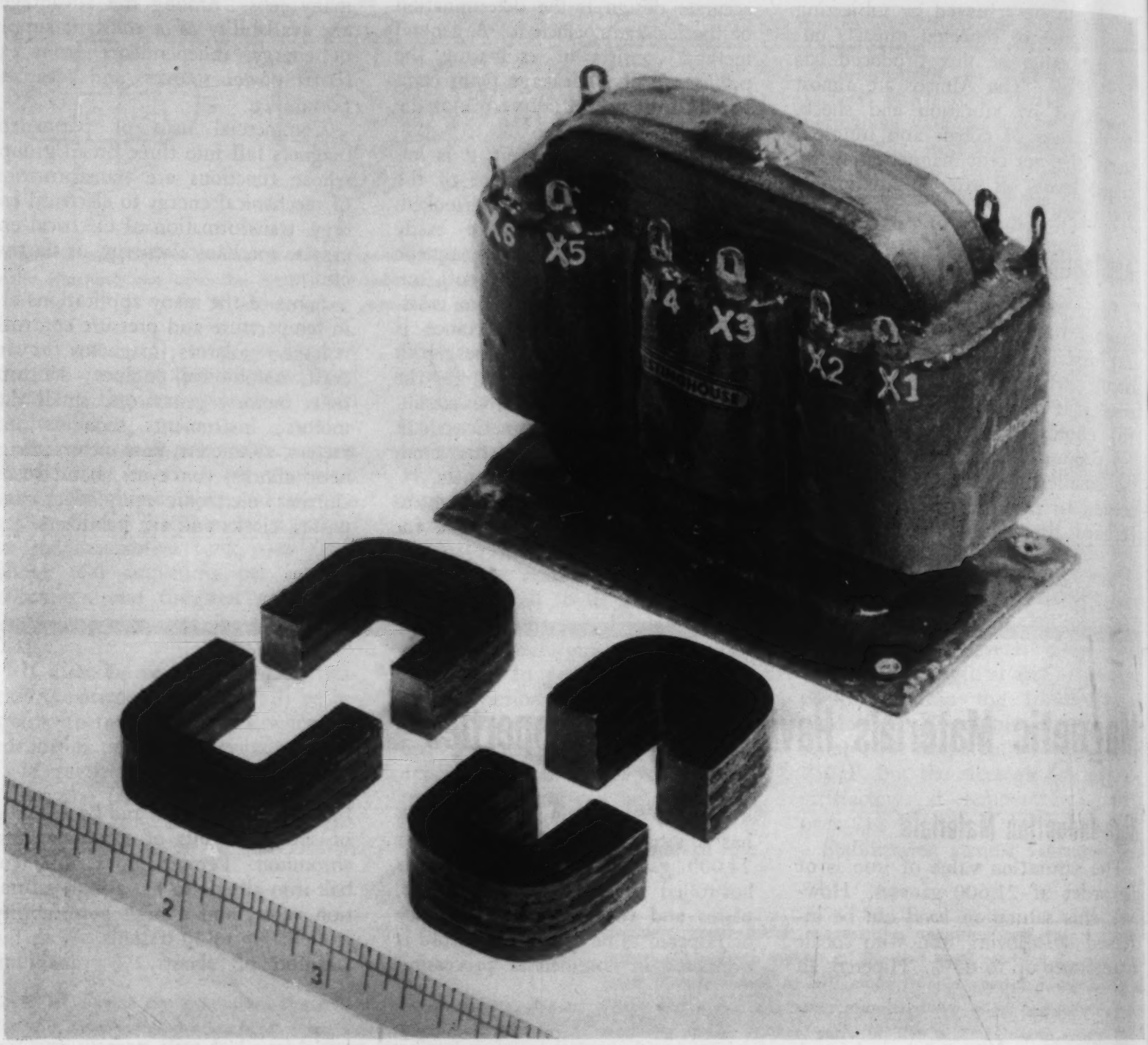
Some of the many applications are in temperature and pressure controls, voltage regulators; magnetos for aircraft, automotive engines; synchronous motors, generators, small d.c. motors; instruments such as ammeters, voltmeters, flow meters; magnetic chucks, conveyors, hand tools, clutches; electronic equipment; compasses, clocks and arc stabilizers.

Magnetic Materials Having Special Properties

High-Induction Materials

The saturation value of iron is of the order of 21,600 gausses. However, this saturation level can be increased by alloying iron with cobalt in amounts up to 65%. Hiperco, an iron alloy containing 35% cobalt, has a saturation level slightly over 24,000 gausses. It is available as hot-rolled sheet, cold-rolled strip, plates and forgings. The tendency of Hiperco to be brittle when cold is overcome in commercial processing by special treatments and by addition of small amounts of vanadium and chromium. Permendur, a 50% cobalt-iron alloy also has a high saturation value, and a high permeability in fields up to 50 œrsteds. With the addition of about 2% vanadium,

Very thin strips of Hipernik wound into toroidal form provide "square hysteresis loop" core material for a high grain magnetic amplifier.



Hipersil cores reduce the size and weight of 400-cycle transformer.

Permendur can be cold rolled.

Cobalt-iron alloys ranging from 25 to 50% cobalt would be used widely in industry if it were not for the following disadvantages: (a) the cost of cobalt for metallurgical uses is high; (b) except where used at high saturation values, these alloys must undergo special heat treatment or their magnetic properties are impaired, resulting in high hysteresis losses and low permeability; (c) electrical resistivity is comparatively low. In applications where high flux densities are required at low magnetizing currents, and a saving in weight and space is of prime importance, Hiperco or Permendur should be considered.

Constant-Permeability Materials

When worked at low flux densities, certain alloys have remarkable magnetic characteristics. With special heat treatment, Conpernik, a 50% nickel-iron alloy, is in this class. Permeabilities of 1000 to 2000 are obtainable, constant to within a few percent, in the low-induction region. Perminvar is similar to Conpernik. When properly annealed, Perminvar, consisting of 25 cobalt, 45 nickel and 30% iron, has a permeability of about 400, for flux densities up to 1000 gausses. Since its permeability is almost constant in this range, Perminvar has nearly zero hysteresis loss. Isoperm, basically a nickel-iron alloy (the precipitation types have a few per cent of copper or nickel added) can be processed in such a way as to give a constant permeability between 50 and 60, over a range of magnetizing forces up to 100 œrsteds.

These magnetic materials, which exhibit relatively constant permeabilities, are useful in circuits in which wave-form distortion must be kept to a minimum. If the material is utilized in thin strip, losses are low, and reactors can be designed to have a high ratio of reactance to resistance. Filter coils in communications circuits and loading coils for telephone transmission lines are examples of applications requiring constant permeability core materials.

Temperature-Sensitive Alloys

The Curie point of a metal can be moved along the temperature scale by alloying the metal with other elements. Therefore, it is possible to produce alloys which lose their ferromagnetic properties at almost any

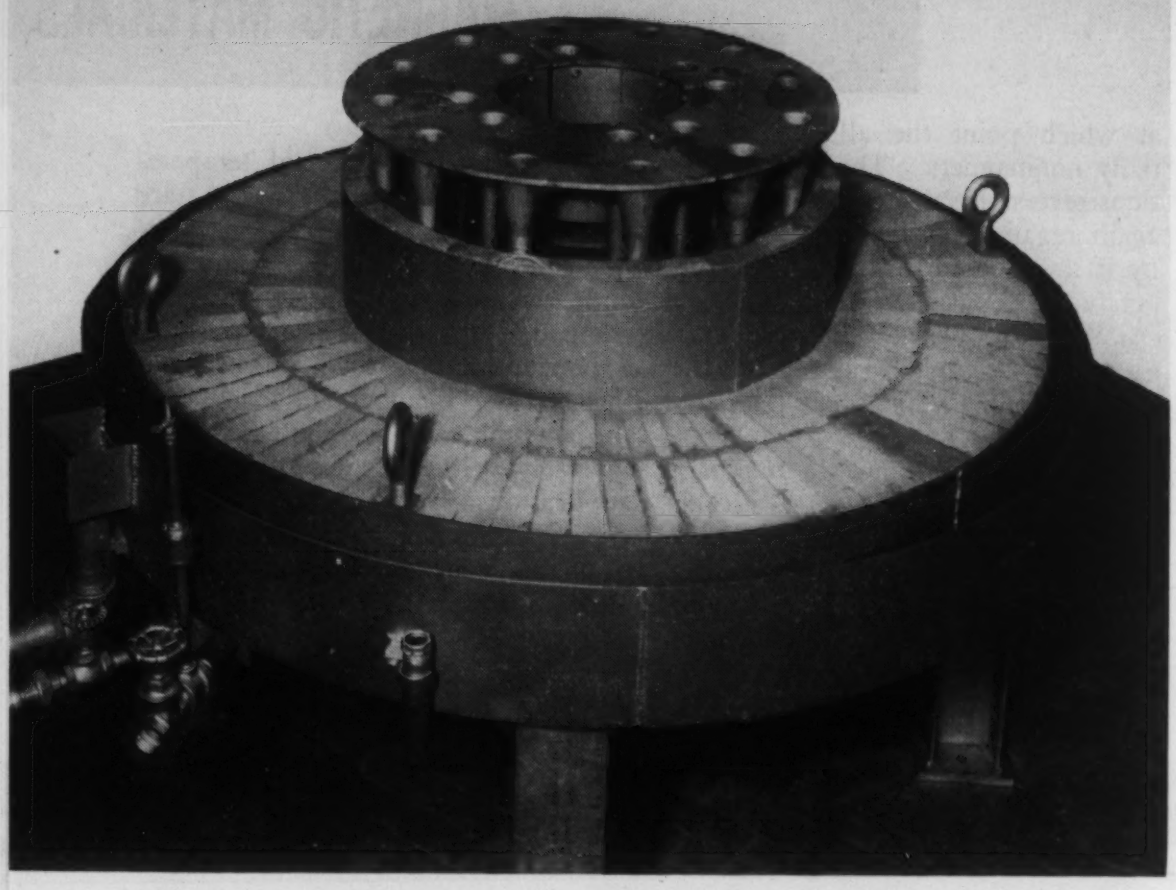
temperature up to 2040 F, which is the critical point for cobalt. Generally, iron-base alloys are selected because of their high permeabilities below the Curie point; however, nickel-copper alloys also possess temperature-sensitive properties.

The principal addition elements used with iron are nickel, chromium, manganese and silicon. For example, a nickel-iron alloy containing 30% nickel is fully magnetic at –20 F. As the temperature of this alloy is increased its magnetic permeability decreases almost linearly with increases in temperature up to 130 F, at which point the alloy is essentially nonmagnetic. This characteristic is reversible; that is, the alloy will again regain its magnetic permeability if it is cooled to its original temperature. Thus, the alloy has a characteristic permeability at each given temperature, regardless of the direction from which this temperature is approached.

The most important thermomagnetic materials are the 30% nickel-iron alloy referred to above, and a 70 nickel-30% copper alloy. The temperature coefficient of the former is higher than that of the monel type.

Principal applications of temperature-sensitive magnetic alloys are temperature-compensation of watt-hour meters, speedometers, and aircraft tachometers. Generally, the compensating alloy is used to shunt a portion of the total flux around the moving member of the meter, the amount of flux shunted varying inversely with temperature. Other applications include temperature-compensation of reactances, and compensation of flux densities in electro-magnets. Thermal relays and temperature regulators also utilize

Banding wire for large d.c. armatures is usually made of nonmagnetic material to reduce eddy current losses in the wire.



Base for furnace used for annealing coiled steel strip is nonmagnetic. The coils are removed by electro-lifting magnets, and magnetic base castings would be carried away along with the charge.

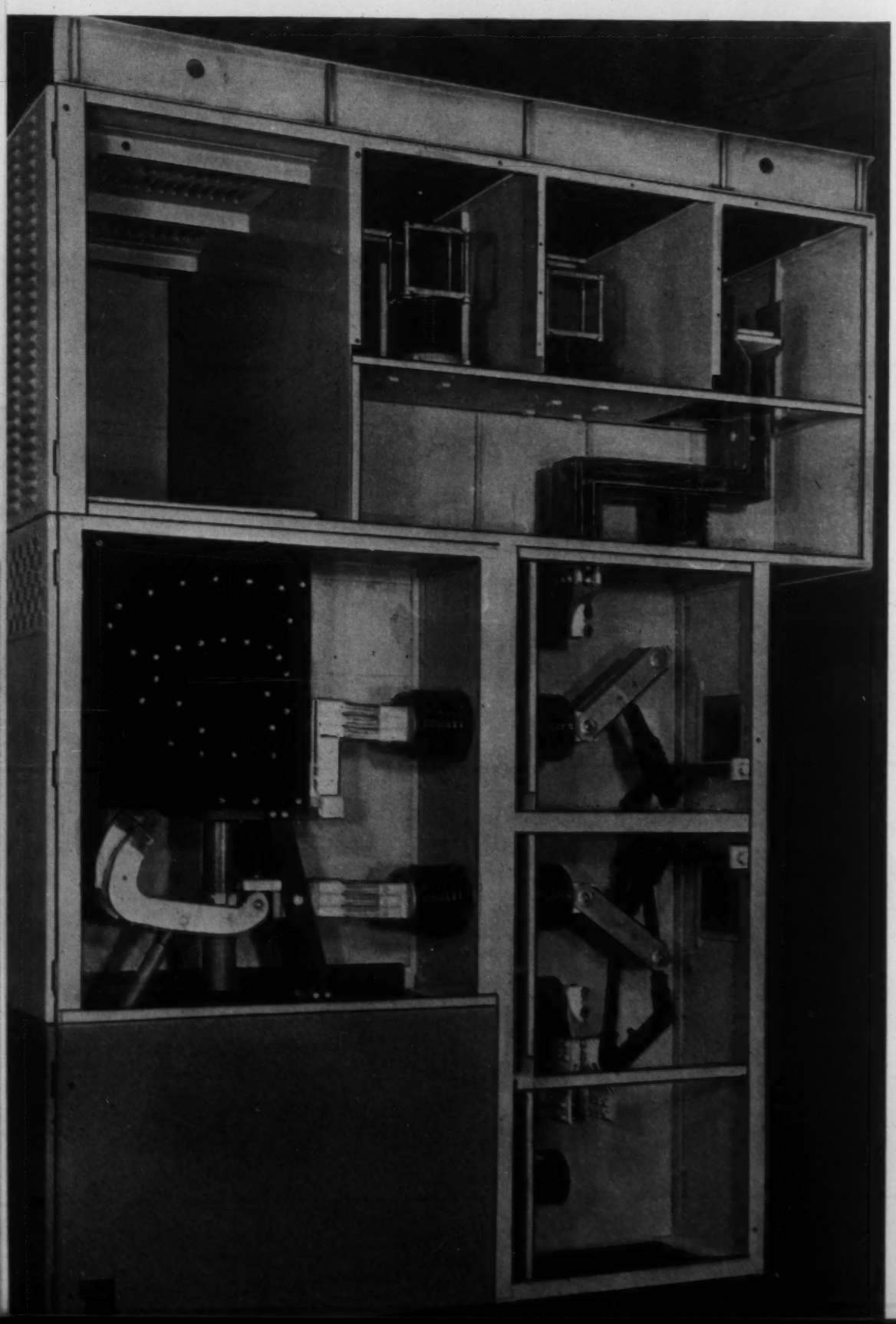
the properties of thermomagnetic materials.

High-Frequency Materials

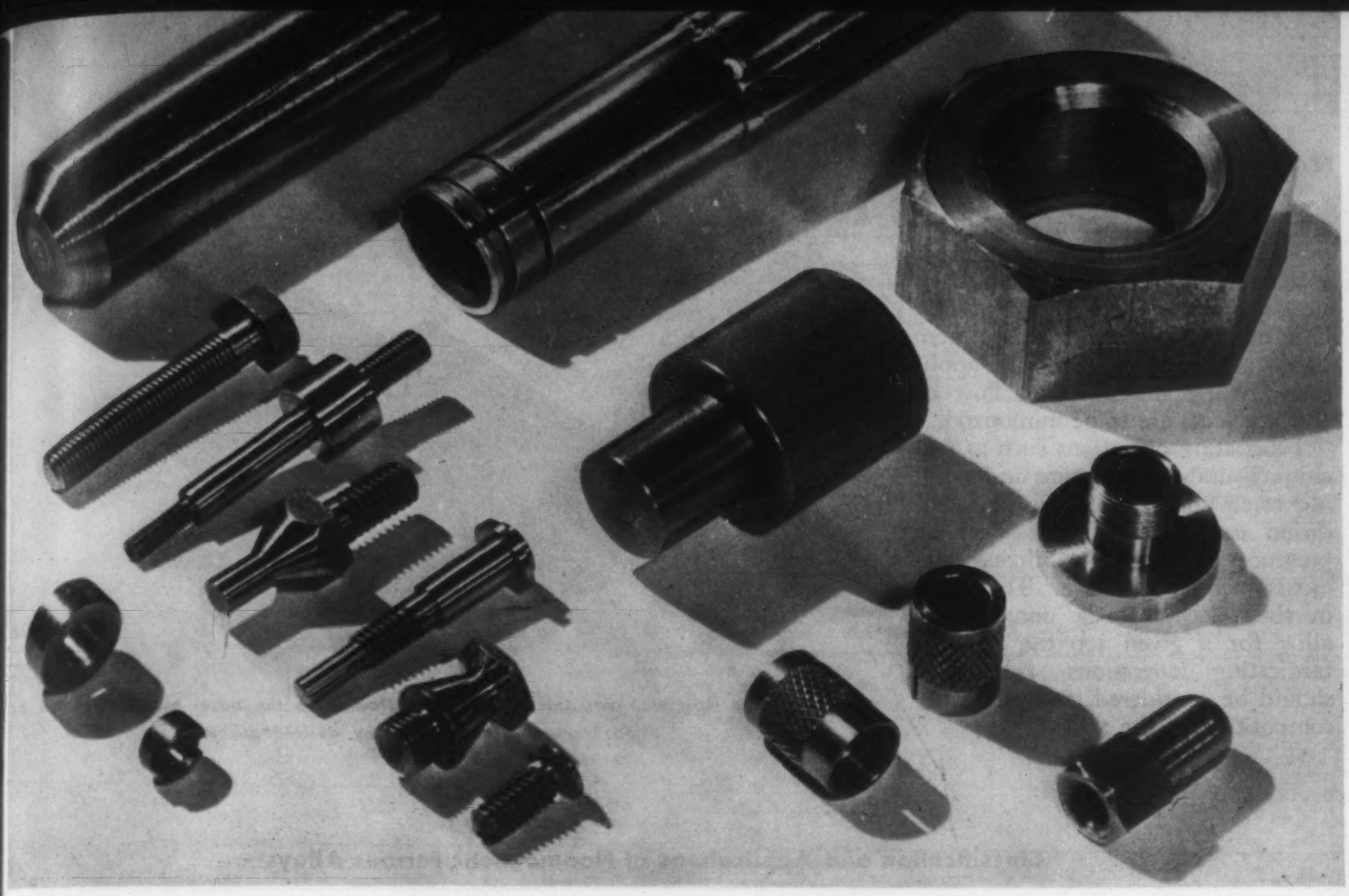
In high frequency applications, the ideal core material for coils and transformers is one having constant permeability and very low hysteresis and eddy-current losses over the working frequency range powdered iron core materials more nearly meet these requirements than thin strip cores. In the powdered construction the particles of magnetic material are mixed with an insulating binder, then compressed into a solid mass, under controlled conditions of pressure and temperature. The quality of these powder cores depends upon use of a particle-insulation which has minimum thickness, but will withstand the desired pressure and temperature. Compressed powdered molybdenum Permalloy (2 molybdenum, 81 nickel, 17% iron) is one of the best of this class of alloys.

The ferrites (metallic oxides) are a second class of magnetic materials well adapted to high frequency application. Some of the ferrite grades have a very poor temperature stability. However, in general, this class of material has a very high resistivity; therefore, it can be used at higher frequencies than metallic magnetic materials. Recently developed ferrites exhibiting rectangular hysteresis loops show promise for use in computors and magnetic memory systems. (See MATERIALS & METHODS, July 1951, p. 76.)

Powdered iron core materials are used in telephone and radio service for high frequency applications. Ferrites are used similarly and can be employed at higher frequencies than metallic materials. Ferrites are being investigated for use in computors and magnetic memory systems.



Typical nonmagnetic switchgear housing.



Nonmagnetic parts made from free-machining stainless steels.

Nonmagnetic Ferrous Alloys

Although this Manual deals primarily with magnetic materials, the discussion of ferromagnetic properties should be extended to recognize some of the characteristics of so-called nonmagnetic alloys.

Electrical equipment often requires use of both magnetic and nonmagnetic alloys in the same piece of apparatus. Inasmuch as distinct differences exist in the mechanical and physical properties of these two classes of materials, different techniques are necessary in the fabrication of component parts.

Metallurgical Characteristics

At ordinary temperatures, pure iron exhibits the magnetic form (ferrite), but if it is heated to high temperatures, it changes to the nonmagnetic form (austenite) at about 1670 F. The process is reversible and the iron will revert to the magnetic form if the temperature is again lowered below the critical value.

If a small fraction of 1% of carbon is added to the iron, the change from austenite to ferrite occurs upon cooling to a temperature somewhat below 1670 F. The transformation temperature can be lowered still more by the addition of other elements, such as nickel, manganese or nitrogen. These elements stabilize the austenite formation, and if the proper combinations of elements are used, it is possible to produce a steel which will retain nonmagnetic properties down to the temperature of liquid air.

Of the addition elements mentioned above, carbon is the cheapest. Carbon up to about 0.85% reduces the temperature at which austenite is stable. However, greater percentages of carbon reduce this temperature no further, and produce excess carbide. Even though nickel is much less active than carbon, it would probably be used in place of all the other elements if it were abundant and low in cost. Manganese is cheaper than nickel but is a less-active stabilizer. Although iron has a greater affinity for carbon than does manganese, the introduction of manganese as a stabilizing agent can result in formation of some unwanted manganese carbide.

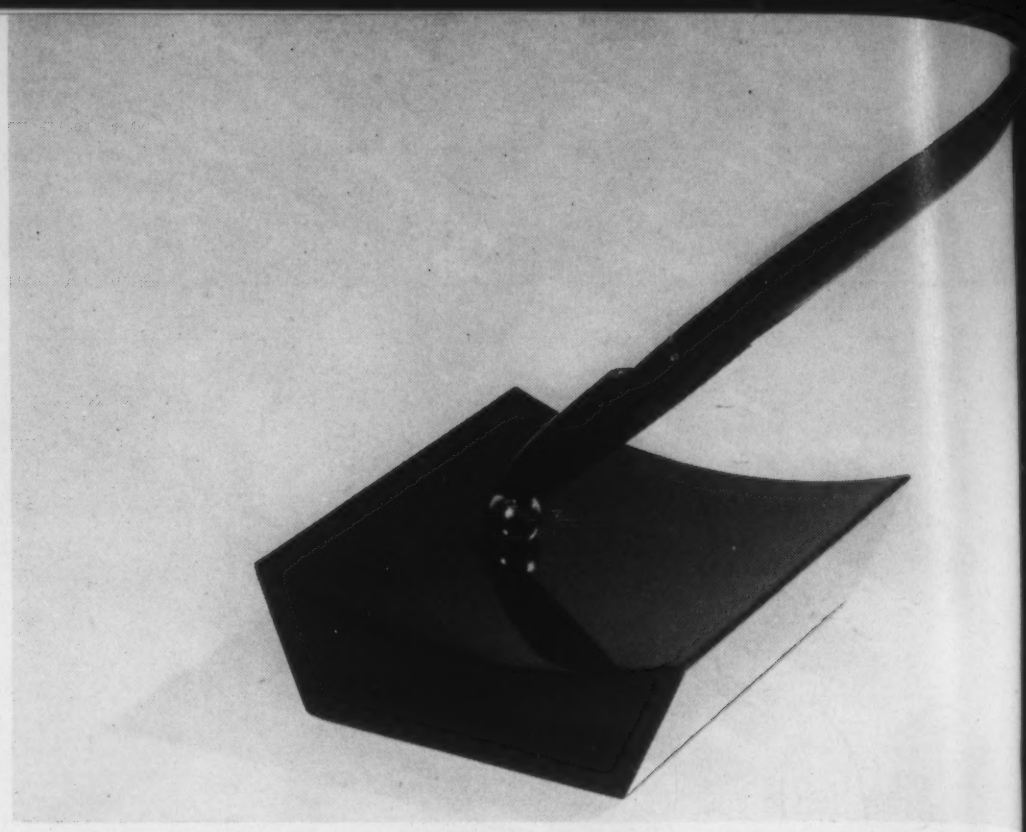
Silicon, molybdenum, chromium and aluminum tend to stabilize ferrite. If, for other metallurgical reasons, any of these metals are used in the production of nonmagnetic steels, a sufficient amount of austenite-stabilizing elements must be added to the melt to offset the effects of the ferrite stabilizing metals. The action of chromium is unusual in that it has some stabilizing effect on both the ferrite and the austenite. The end result of using chromium in some chromium-nickel steels is that a smaller percentage of costly nickel is required to produce nonmagnetic properties.

Applications

As compared with plain carbon steels, nonmagnetic steels have low thermal conductivity, high thermal expansion, are very susceptible to

work hardening, and in general are difficult to machine. Nonmagnetic steels offer high resistance to abrasion, corrosion and shock. Their high electrical resistance makes them particularly suitable for any application where losses due to flow of eddy currents are to be minimized.

Fabricating operations such as machining, drawing, forming and welding often upset the equilibrium condition established in the steel by presence of various stabilizing elements mentioned above. Therefore, in the selection of a nonmagnetic alloy for a given job the type of fabricating operations anticipated should be considered, as well as the composition of the alloy.



A permanent magnet keeps this pen holder attached to the base, but allows it to be tilted freely or pivoted to any desired position.

Classification and Applications of Nonmagnetic Ferrous Alloys

Classification	Nom. Comp. of Essential Elements, %	Magnet Permeability, (H=200)	General Properties	Typical Applications
Chromium-Nickel Steels	17.5 to 25 Cr 8 to 20 Ni Up to 0.15 C	1.01–1.02	Wrought quench annealed or cold drawn form. High corrosion and heat resistance. Free from galling and friction between sliding surfaces. High decorative value. Can be produced readily.	Automatic screw machine parts. Helical steel springs. Banding wire for armatures of d.-c. machines.
Carbon-Manganese-Nickel Steels	0.20 to 0.85 C 10 to 13 Mn 2.5 to 9 Ni	1.02–1.05	Wrought, annealed form. Corrosion resistance approx. same as plain carbon steels. May undergo surface decarburization if %C is high. Generally lowest metal cost, yet adaptable to usual shop operations.	Cubicles for electrical gear. General structural purposes where prevention of losses due to eddy-current heating is desirable.
Carbon Manganese Steels	1.0 to 1.4 C 10.5 to 15 Mn	1.3	Cast, water quenched. Strong, tough materials. Resists heavy abrasion. Highly sensitive to work hardening; virtually impossible to machine. Not recommended for use at temperatures above 500 F.	Induction furnace shells. Wearing plates. Face plates for lifting magnets.
Carbon-Nickel Cast Iron	3 C 20 Ni (May include Cu-5 to 6% with reduced % Ni)	1.03	Cast form only. Relatively high resistivity. Good machinability; poor weldability. Good corrosion resistance. Is available in nodular cast iron.	Resistance grids. Finger plates. Bases for annealing furnaces.

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MATERIALS & METHODS
April • 1953
Number 249

Materials Engineering File Facts

Materials Data Sheet

Fluorocarbon Plastics

The fluorocarbon plastics are highly resistant to chemical attack, have excellent electrical insulating properties, and are nonflammable. Kel-F can be handled by conventional injection and compression molding methods, but Teflon does not flow. Teflon is fabricated by procedures resembling those used for the production of metal powder parts.

Typical Properties

Type	ASTM Test Conditions	Polytrifluorochloroethylene (Kel-F and Fluorothene)	Polytetrafluoroethylene (Teflon)
PHYSICAL PROPERTIES			
Specific Gravity	D792–48T	2.1	2.1–2.3
Thermal Cond, Btu/Hr/Sq Ft/In./F	(Cenco-Fitch)	0.42	1.7
Coeff of Exp per F	D696–44	3.9×10^{-5} (a)	5.5×10^{-5} (b)
Spec Ht, Btu/Lb/F	—	0.22	0.25
Refractive Index	D542–42	1.43	1.35
MECHANICAL PROPERTIES			
Mod of Elast in Tension, Psi	D638–49T	2.3×10^5	—
Tensile Str, Psi	D638–49T	5700 (c)	1500–2500 (c)
Elong in 2 In., %	D638–49T	28–36	150
Hardness, Rockwell	D785–48T	R45–R113	—
Hardness, Durometer	D676–47T	D80	D55
Impact Str, Izod Notched, (Ft-Lb per In. of Notch)	D256–47T	3.6	4.0
Mod of Elast in Flexure, Psi	D747–48T	1.8×10^5	0.6×10^5
Flexural Str, Psi	D790–48T	8250	Did not break
	D650–42T	—	2000
Compressive Stress at 1% Deformation, Psi	D695–49T	(d)	600
ELECTRICAL PROPERTIES			
Elect Res, Microhm-Cm @ 68 F	D257–46	1.2×10^{12}	$>10^9$
Dielectric Str (Short Time) Volts/Mil (⅛-In. Thick)	D149–44	2500	450
Dielectric Constant:			
60 Cycles	D150–47T	2.7	2.0
1,000,000 Cycles	D150–47T	2.4	2.0
Power Factor:			
60 Cycles	D150–47T	0.02	0.0005
1,000,000 Cycles	D150–47T	0.008	0.0005
FABRICATING PROPERTIES			
Injection Molding Pressure, Psi	—	20,000–60,000	— (e)
Compression Molding Pressure, Psi	—	500–15,000	—
Injection Molding Temp F	—	440–550	—
Compression Molding Temp F	—	445–500	—
CORROSION RESISTANCE	Excellent resistance to weak and strong acids and alkalies; halogenated compounds cause slight swelling of polytrifluorochloroethylene, no effect on polytetrafluoroethylene.		
USES	—	Chemical piping, gaskets and packings, valve and pump parts, electrical insulators, electronic parts. (f)	Chemical pipes, valves and valve liners, gaskets and packings, pump bearings and impellers, electrical and electronic equipment, anti-adhesive coatings.

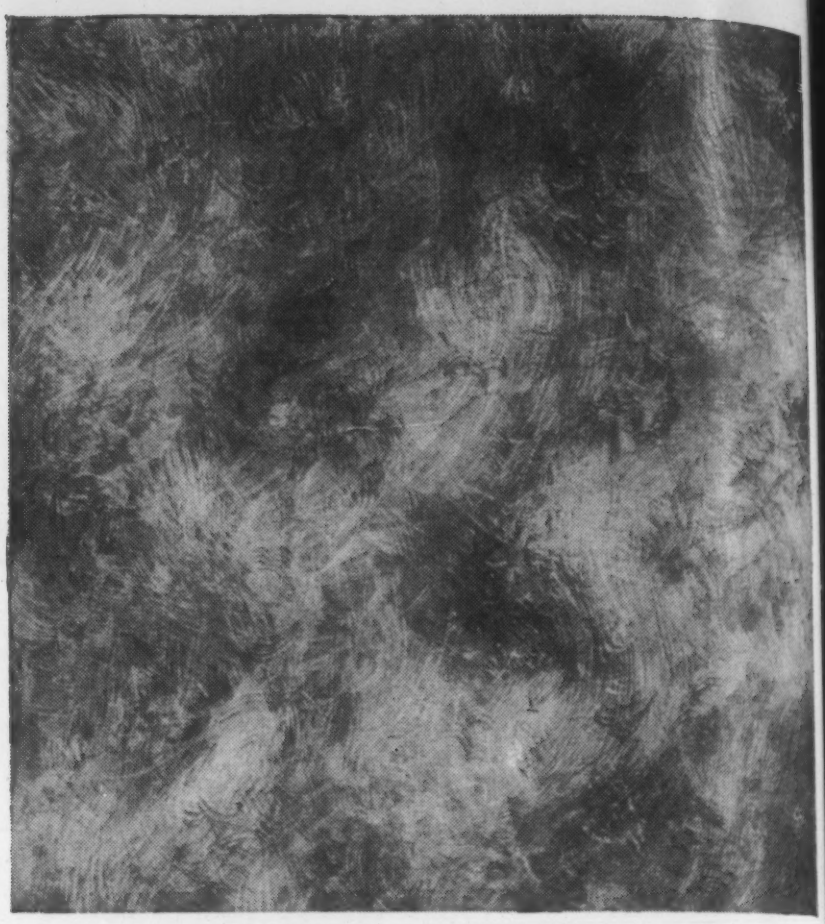
NOTES:

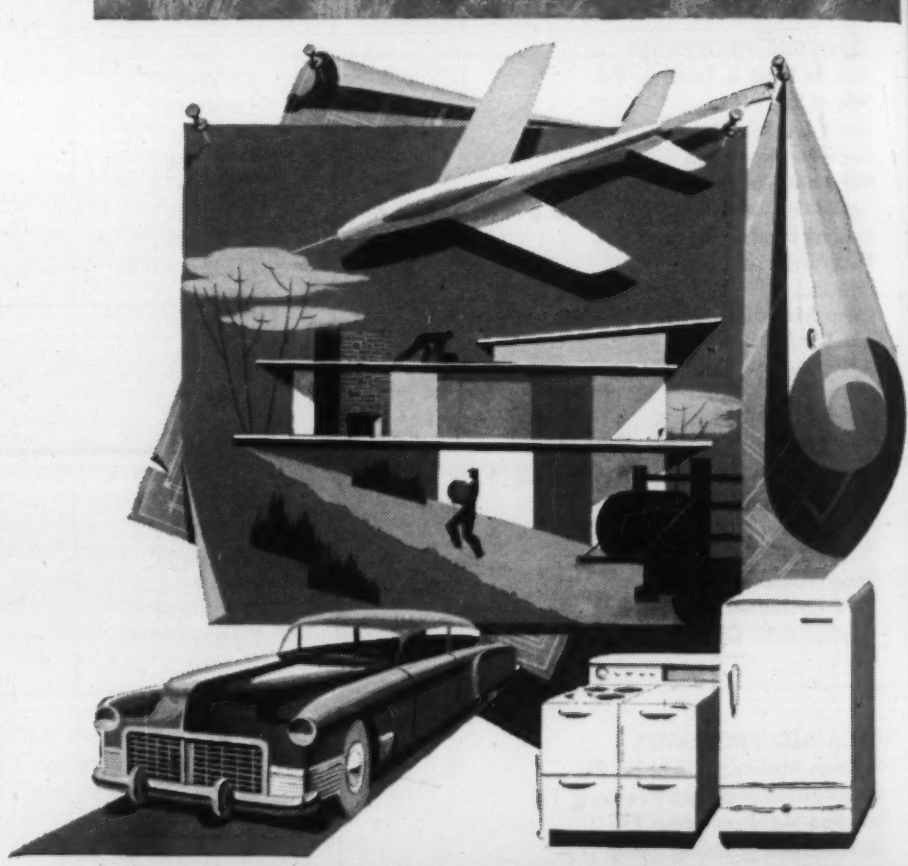
(a) *68 to 300 F*
(b) *77 to 140 F*
(c) *Oriented film up to 15,000 psi for Teflon, 30,000 psi for Kel-F.*
(d) *Compressive strength 32,000 to 80,000 psi.*
(e) *Molded by process resembling powder metallurgy.*
(f) *Kel-F can be supplied in plasticized and unplasticized form.*

Prepared with the assistance of M. W. Kellogg Co., E. I. du Pont de Nemours & Co., Inc., and Plax Corp.

RCI PLYOPHENS

the Proven Binders for Rock Wool and Fiber-Glass Insulation!





Reichhold chemists developed these water-soluble phenolic resins specifically to meet the requirements of manufacturers of rock wool and fiber-glass insulation. RCI PLYOPHENS are low cost heat and water resistant binders with a demonstrated ability to reduce stack losses. And PLYOPHEN economy doesn't end there . . . you'll find you can obtain a high quality end product with up to 10% less resin! These top-grade phenolic binders are manufactured to exact standards of uniformity with the finest equipment available in the world today. For complete information and working samples, write direct to:

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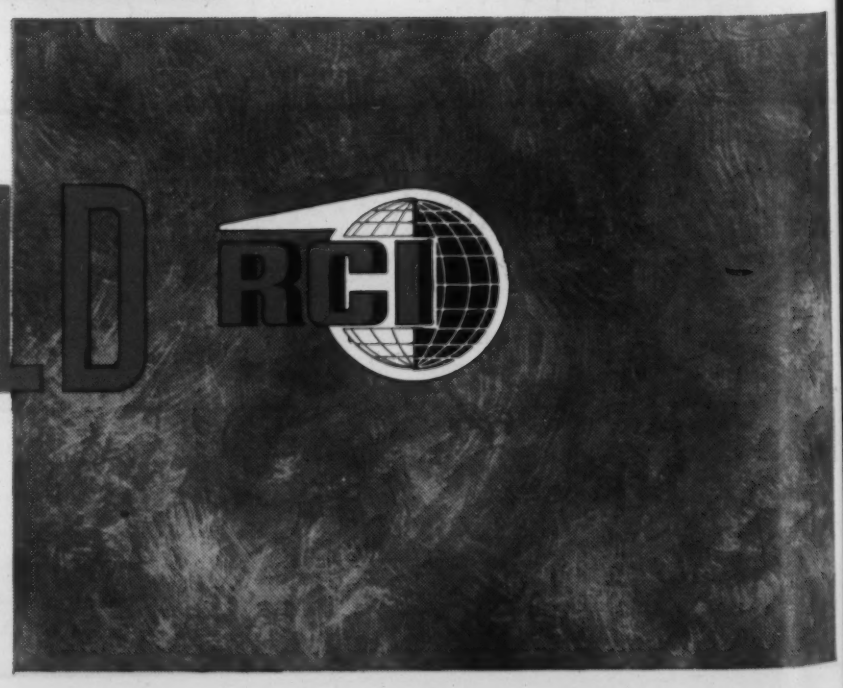


Synthetic Resins • Chemical Colors • Phenolic Plastics • Phenol
Glycerine • Phthalic Anhydride • Maleic Anhydride
Sodium Sulfate • Sodium Sulfite

Properties and Heat Treatment of Diffusion Hardening Permanent Magnet Alloys

Name	Nominal Composition, %					Average Magnetic Properties							
	Al	Ni	Co	Cu	Others	Br, Gauss	Hc, Oersteds	BH Max, Gauss-Oersteds $\times 10^{-6}$	Bd at BH Max, Gauss	Hd Point, Oersteds	Saturation, $4\pi J_s$ Gauss	Curie Point, C	Saturation Magneto-Striction $\pi_s \times 10^6$
ISOTROPIC ALLOYS													
Alnico III	13	24	—	3.5	—	6,200	480	1.25	4,000	312	9,850	725	6*
Alni b[1]	12	32	—	—	Ti 0–0.5	4,700	700	1.25	2,900	432	—	—	—
Alnico II	10	17	12	6	—	8,000	500	1.7	5,200	325	12,500	800	—
Alnico b[1]	10	20	13.5	6	Ti 0.25	6,500	630	1.7	4,200	406	12,300	810	—
Hynico II[1]	—	—	—	—	—	5,500	920	1.6	3,100	517	—	—	—
Alnico I	12	21	5	—	—	6,900	490	1.4	4,400	320	—	—	—
Alnico IV	12	27.5	5	—	—	5,750	695	1.3	3,250	400	—	—	—
Alnico XII	6	18	35	—	Ti 8.0	5,950	975	1.6	3,100	515	—	—	—
Oerstit 800[2]	9	18	19	4	Ti 4	6,600	750	1.95	4,000	487	—	—	—
New K. S.[3]	3.7	17.7	27.2	—	Ti 6.7	6,500	850	2.0	3,750	535	—	—	—
ANISOTROPIC ALLOYS													
Alcomax I[1]	7.5	11	25	3	Ti 1.5	12,000	475	3.5	9,400	370	—	—	—
Alcomax II[1]	8	11	21	4.5	—	12,400	575	4.3	9,600	450	14,000	840	20*
Alcomax III[1]	8	13.5	24.5	3	Cb 0.5–1.0	13,000	625	5.2	10,000	500*	14,000	860	—
Alcomax IV[1]	8	13.5	24.5	3	Cb 1.0–3.0	11,900	775	4.6	8,800*	560*	13,000	860	—
Alnico V	8	14	24	3	Ti 3.0 max	12,500	575	4.6	10,400*	460*	14,000	—	22*
Alnico VI	8	15	24.5	3	Ti 0.5–1.0	10,500	725	3.75	7,500	500	—	—	—
Hycomax[1]	9	21	20	1.6	—	9,500	830	3.3	6,100	535	13,100	865	21*

Name	Physical and Mechanical Properties					Heat Treatment	
	Density, Lb/Cu In.	Elect Resist, Microhm-Cm	Coef of Linear Expansion per °F	Modulus of Elasticity, Psi	Hardness Rockwell, C	Hardening Temp, F	Tempering Temp, F
ISOTROPIC ALLOYS							
Alnico III	0.252	77	7.7×10^{-6}	25,400,000	50	2100 a.c.	1100 (optional)
Alni b[1]	—	—	—	—	—	2100 o.q.	1100
Alnico II	0.267	65	7.0×10^{-6}	31,600,000	54	2275 a.c.	1100
Alnico b[1]	0.267	—	7.0×10^{-6}	28,700,000	54	2275 a.c.	1100
Hynico II[1]	—	—	—	—	—	—	—
Alnico I	0.248	75	7.0×10^{-6}	—	45	2200 a.c.	1300
Alnico IV	0.252	75	7.3×10^{-6}	—	45	—	—
Alnico XII	0.259	62	6.0×10^{-6}	—	58	—	—
Oerstit 800[2]	—	—	—	—	—	—	—
New K. S.[3]	0.266	55	6.5×10^{-6}	—	—	—	—
ANISOTROPIC ALLOYS							
Alcomax I[1]	0.263	—	—	—	—	2280 m.f.	1100
Alcomax II[1]	0.270	55	6.5×10^{-6}	28,000,000	54	2280 m.f.	1100
Alcomax III[1]	0.265	—	—	—	—	2280 m.f.	1100
Alcomax IV[1]	0.266	67	—	—	—	2280 m.f.	1100
Alnico V	0.263	47	6.3×10^{-6}	—	50	2330 m.f.	1200
Alnico VI	0.267	50	6.3×10^{-6}	—	56	—	—
Hycomax[1]	0.261	64	6.8×10^{-6}	27,000,000	50	2330 m.f.	1100

NOTES:

[1] *British designation*
[2] *German designation*
[3] *Japanese designation*

* *Approximate*

a.c.—air cooled
o.q.—oil quenched
m.f.—cooled in magnetic field

Adapted from Ferromagnetic Properties of Metals and Alloys, by K. Hoselitz, by permission of The Clarendon Press, Oxford.

Specify Inco Castings

—and you get 7 Specific Advantages

Advantage No. 1 — You get castings that will give you extra long service life under destructive service conditions. That's because they are made of Inco Nickel Alloys, which are especially designed to withstand high temperatures, corrosion, abrasion and galling.

Advantage No. 2 — You get castings in whatever size or shape you need. Inco has specialized in castings for over 47 years and is equipped to make your castings whether they weigh a few ounces or tons.

Advantage No. 3 — You get sound, uniform castings because Inco's furnaces melt only Inco Nickel Alloys. There is no chance of harmful furnace pick-up from previous melts of other metals.

Advantage No. 4 — You get high quality castings because every one is made to meet or exceed Government specifications for these high Nickel Alloys.

Advantage No. 5 — You get the benefit of Inco's help in solving your metal problems based on wide experience in field and laboratory testing of Nickel Alloys.

Advantage No. 6 — You get Inco Nickel Alloy castings made at Inco's own foundry; your assurance of sound, dependable castings.

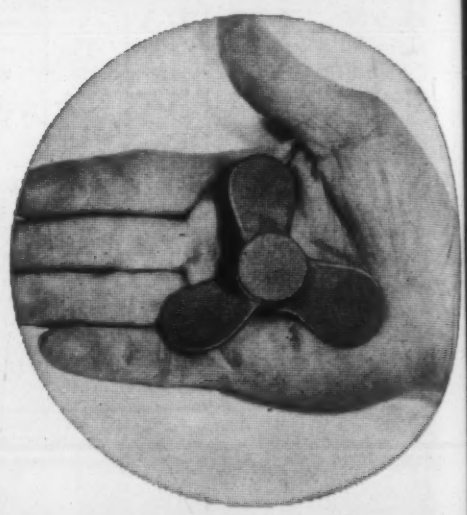
Advantage No. 7—Even castings you previously thought impractical to produce in Monel®, Nickel or Inconel® can often be cast by Inco's specialists.

Whenever you need a casting to withstand destructive service conditions such as corrosion, high temperature, abrasion and galling, send the details — with a blueprint, if possible — to Inco for a practical answer to your problem. Inco casting specialists will be glad to study your problem and suggest a solution. They will also furnish you with cost and delivery estimates on all rated orders.

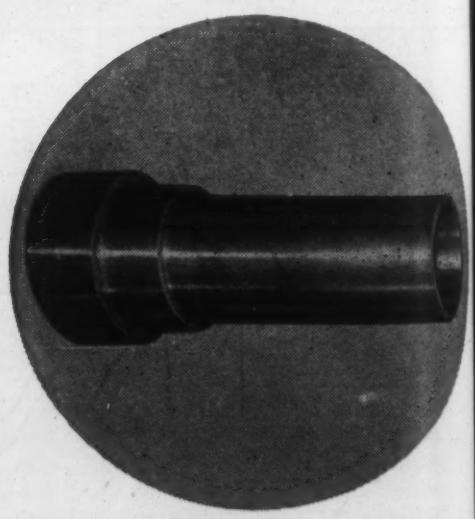
Write, The International Nickel Company, Inc.,
67 Wall Street, New York 5, N. Y.

Inco Castings SAND, CENTRIFUGAL, PRECISION

This 3023-lb. propeller is used in a pump supplying sea water to condensers for a turbine generator in a chemical plant. It was cast in Monel for resistance to corrosion and erosion.



This 5-oz. propeller is part of a beater in a chemical and food mixing machine. Monel is used as a safeguard against various corrosives it will encounter.



This shaft sleeve for a salt water circulating pump was cast in "S"® Monel for resistance to abrasion. To save metal and machining time, it was centrifugally cast in three different outside diameters leaving only sufficient stock for finish machining.

Materials Engineering File Facts

Properties and Heat Treatment of Magnet Steels

Name	Nominal Composition, %				
	C	W	Cr	Co	Others
Carbon Steel	0.9–1.0	—	—	—	—
Tungsten Steel	0.7	6.0	0.3	—	—
Chromium Steel	0.9	—	3.5	—	—
C-M Steel	0.95	—	5.0	—	Mn 1.0
2 Cobalt-4% Chromium Steel	1.0	0.5	3.8	2.0	Mn 0.25
3% Cobalt Steel	1.0	0–1.0	5–9	3	Mo 0–1.5
6% Cobalt Steel	1.0	0–1.0	5–9	6	Mo 0–1.5
9% Cobalt Steel	1.0	0–1.0	5–9	9	Mo 0–1.5
15% Cobalt Steel	1.0	0–1.0	5–9	15	Mo 0–1.5
17% Cobalt Steel	0.75	8	2.5	17	—
20% Cobalt Steel	1.0	0–1.0	5–9	20	Mo 0–1.5
35% Cobalt Steel	0.9	5–6	3–6	35	—
40% Cobalt Steel	0.7	5	5	40	—

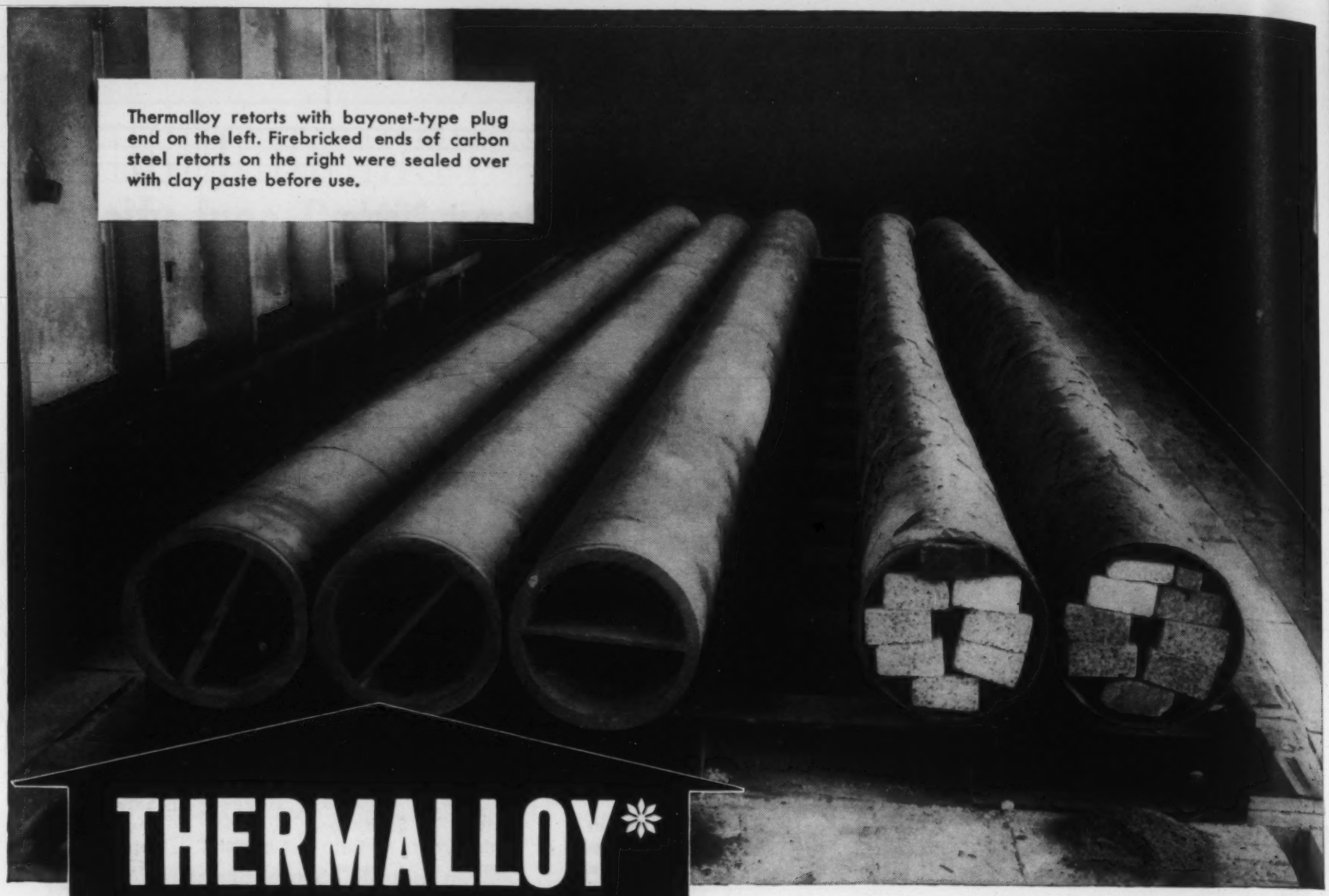
Name	Average Magnetic Properties							
	Br, Gauss	Hc, Oersteds	BH Max, Gauss-Oersteds X10^{-6}	Bd at BH Max, Gauss	Hd Point, Oersteds	Saturation, $4\pi J_s$ Gauss	Curie Point, C	Saturation Magneto-striction, $\pi_s \times 10^6$
Carbon Steel	9,500	50	0.2	6,200	32	19,800	770	−2.8
Tungsten Steel	10,500	66	0.3	6,850	44	16,500	760	3
Chromium Steel	9,800	70	0.285	6,300	45	17,000	745	—
C-M Steel	9,700	75	0.35	6,750	52	17,300	760	—
2 Cobalt-4% Chromium Steel	9,800	83	0.39	6,850	57	18,500	775	—
3% Cobalt Steel	7,200	130	0.35	4,400	80	15,800	804	—
6% Cobalt Steel	7,500	145	0.44	4,800	92	16,100	832	—
9% Cobalt Steel	7,800	160	0.50	5,000	100	16,800	840	19
15% Cobalt Steel	8,200	180	0.62	5,300	117	17,200	840	20
17% Cobalt Steel	9,250	160	0.65	6,200	105	—	—	—
20% Cobalt Steel	8,750	205	0.75	5,800	128	—	—	—
35% Cobalt Steel	9,000	250	0.95	5,850	162	16,300	890	40
40% Cobalt Steel	10,000	242	1.03	6,500	—	—	—	—

Name	Physical and Mechanical Properties					Hot Working and Heat Treatment		
	Density Lb/Cu In.	Elect Resist Microhm-cm	Coef of Linear Expansion per F	Modulus of Elasticity, Psi	Hardness Rockwell, C	Hot Working Temp, F	Annealing Temp (for Machining) F	Hardening Temp, F
Carbon Steel	0.280	18	6.8 x 10^{-6}	29,000,000	64	2100–1475	1360 s.c.	1435 w.q.
Tungsten Steel	0.292	30	6.9 x 10^{-6}	30,000,000	63	2000–1750	1380 s.c.	1470 w.q.
Chromium Steel	0.279	29	7.1 x 10^{-6}	30,000,000	63	2000–1550	1380 s.c.	1525 w.q.
C-M Steel	0.279	34	7.2 x 10^{-6}	30,000,000	62	2000–1550	1380 s.c.	2000 b.c.; 1250 o.q.; 1560 o.q.
2 Cobalt-4% Chromium Steel	0.281	29	7.1 x 10^{-6}	30,000,000	60	2000–1650	1300 s.c.	1600 o.q.
3% Cobalt Steel	0.277	—	7.1 x 10^{-6}	30,000,000	62	2000–1650	1440 s.c.	2100 a.c.; 1435 s.c.; 1830 a.c.
6% Cobalt Steel	0.279	—	7.2 x 10^{-6}	30,000,000	62	2000–1650	1440 s.c.	2100 a.c.; 1435 s.c.; 1830 a.c.*
9% Cobalt Steel	0.280	30	6.8 x 10^{-6}	31,000,000	63	2000–1650	1440 s.c.	2100 a.c.; 1435 s.c.; 1830 a.c.*
15% Cobalt Steel	0.284	—	6.8 x 10^{-6}	31,000,000	64	2000–1650	1440 s.c.	2100 a.c.; 1435 s.c.; 1830 a.c.*
17% Cobalt Steel	0.301	28	8.8 x 10^{-6}	—	63	—	—	—
20% Cobalt Steel	—	—	—	—	—	—	—	—
35% Cobalt Steel	0.293	27	6.0 x 10^{-6}	30,300,000	62	2000–1650	1440 s.c.	2100 a.c.; 1435 s.c.; 1750 o.q.
40% Cobalt Steel	0.293	25	9.7 x 10^{-6}	—	63	—	—	—

NOTES:
s.c.—slow cool
w.q.—water quench
o.q.—oil quench
a.c.—air cool
b.c.—air blast cool

* *Sometimes oil quenched instead of air cooled.*

Adapted from Ferromagnetic Properties of Metals and Alloys, by K. Hoselitz, by permission of The Clarendon Press, Oxford.



Thermalloy retorts with bayonet-type plug end on the left. Firebricked ends of carbon steel retorts on the right were sealed over with clay paste before use.

THERMALLOY*

outlasts carbon steel retorts . . . 28 to 1

In a plant of a large eastern tool and specialty steel manufacturer, long, pipe-like retorts are used to anneal and heat-treat high-speed carbon and alloy steel bar stock in hood-type furnace equipment. Temperatures range up to 1650°F. during the annealing or heat-treating cycle that may last 30 hours.

Under these conditions, this manufacturer found that wrought carbon steel retorts scaled excessively and also distorted and flattened during operation . . . limiting service life to about 500 cycle hours. For the same operation, centrifugally cast Thermalloy retorts showed no measurable scale loss and maintained uniform wall thickness and shape. When last reported, Thermalloy retorts had been operating over 14,000 cycle hours and were still in perfect condition.

As the wrought carbon steel retorts became distorted, the plugs necessary to seal the open ends would not fit. Firebrick and a clay paste were used to seal the ends against infiltration of furnace gases. This made uniform annealing or heat-treating practically impossible. However, Thermalloy retorts, with plug ends designed by Electro-Alloys, afforded practically gas-tight seals and much greater ease of handling.

Today, this manufacturer is replacing all of the wrought carbon steel retorts with high heat-resistant Thermalloy retorts. Perhaps the same operating economy may interest you in Thermalloy retorts, furnace parts, trays, racks, pots or muffles. For full information, call in an Electro-Alloys engineer or write Electro-Alloys Division, 4001 Taylor Street, Elyria, Ohio.

*Reg. U. S. Pat. Off.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION
ELYRIA, OHIO

New Materials and Equipment

Polyvinyl Chlorides for Calendering, Coating and Extruding

Introduction of the newest product in the series of Pliovic polyvinyl chloride resins has been announced by the Chemical Div., *Goodyear Tire & Rubber Co.*, Akron 16. Designated Pliovic G80V, the new resin is a general purpose, straight vinyl material having an approximate intrinsic viscosity of 0.80. It is designed to complement the use of the previously announced Pliovic G90V in calendering, coating and extruding operations.

Because its intrinsic viscosity is lower than that of G90V, the new product's processing temperature requirements are 20 to 40 F lower than those of G90V. Thermal stability of the new product is said to be comparable to G90V. This, combined with lower fusing temperatures, permits more rapid calendering and extrusion. Both clear and pigmented products are said to benefit from the resin's excellent light stability and good color.

Recommended uses for the resin are for rainwear, draperies, upholstery and shower curtains, as well as for many industrial applications.

Following low temperature (310 F) milling of Pliovic G80V, clarity of 30-mil sheet is shown by absence of unfused resin particles.

Decorative Plating Process Requires No Nickel

Promat Div., Poor & Co., 851 S. Market St., Waukegan, Ill., has developed two decorative plating processes for use on parts commonly having a copper-nickel-chromium finish. No nickel is employed in the new processes, which are designated as Probrite CR-723, a buffing grade deposit for parts that can be color buffed after plating.

Both finishes can be deposited over steel or copper, according to the company. They can also be readily chromium plated. A new Promat sealer for use over the chromium plating is said to prolong the life of the finish, according to the manufacturer.

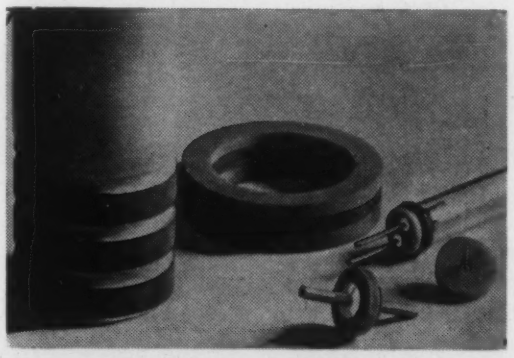
Brilliance of the finishes is said to be comparable to copper-nickel-chromium. Protection of steel against red rust is reported to be as high as 200 hr in a standard salt spray test when Probrite is chromium plated and sealed. This is approximately twice the test life of good quality copper-nickel-chromium.

Metal Ceramic Seal Withstands Temperatures of 1200 F

A new process for metallizing ceramic materials, to provide for attached metal parts, has been announced by *Advanced Vacuum Products, Inc.*, P. O. Box 197, Southport, Conn. Seals produced by this method, Process AV55, are said to withstand temperatures of 1200 F, surpass Jan thermal shock requirements, and maintain a vacuum-tight seal under a wide range of temperature and pressure combinations.

The above characteristics are obtained by combining a selected group of ceramic materials with new design principles and the carefully-controlled AV55 metallizing process. In many applications, nonmagnetic conductors can be used, resulting in lower loss factors at high frequencies than other sealing methods. Plating upon the metalized surface will not peel or blister, as is common in low temperature metallizing processes.

Process AV55 will be available at first on the basis of custom design and manufacture. Applications include: high-quality electronic and electrical devices, ignition systems, plumbing and a wide variety of components needed for aircraft, missiles, chemical and heating apparatus.



New process for metallizing ceramic materials effects a seal vacuum-tight under a wide range of temperature and pressure combinations.

Glass-Fiber Reinforced Vinyl Material Offers Many Applications

A new industrial fabric with characteristics that are expected to make it potentially useful in a multitude of industrial applications, has been developed by *Thermoplastic Fabrics Corp.*, 1457 Broadway, New York. Constructed of two sheets of vinyl film and a center layer of Fiberglas fabric which are laminated together under heat and pressure to form a single sheet, Fortron is said to be strong, light weight and nonabsorbent. It will neither stretch nor shrink and will not crack at temperatures as low as —30 F.

Because of its light weight—as little as ½ oz per sq yd, depending on the quantity of Fiberglas and vinyl used—it is very easy to handle, even in large sheets. Since it does not absorb water, it is as easy to handle wet as dry. Its use can reduce labor and handling costs of cargoes and shipments it protects, according to the manufacturer.

Among the many possible uses foreseen for the material are as wrapping and packaging material, shrouding, and tarpaulins in industries such as mining, transportation and many types of manufacturing.

Electronic sealing makes possible the production of air- and water-tight sheets of Fortron of any size. Special techniques are used for securing grommets when use of the fabric as a tarpaulin is anticipated. Both colored and clear translucent types are available.

Extreme light weight and nonabsorbent properties of this glass-fiber reinforced vinyl material are shown here.

Three New Silicone Insulating Materials Announced

Three new silicone resins, one designed for coating glass cloth, another for impregnating Class H equipment and a third for bonding glass laminates, have been announced by *Dow Corning Corp.*, Midland, Mich. According to the company, all three of the resins have superior thermal life, as indicated by the retention of their dielectric properties after long exposure to very high temperatures. Significant improvements in handling characteristics have also been reported.

The new coating resin, Dow Corning Silicone Resin 994, is described as having over three times the thermal life of the earlier silicone resins designed for this purpose. Resin 993 is the original silicone resin used in the accelerated life testing of silicone insulated motors that lead to the establishment of AIEE standards for Class H insulation. Resin 994 is also said to have about four times the thermal life of another earlier silicone resin—Dow Corning Silicone Varnish 935. Comparison between 994 and 935, however, is not wholly fair since resin 935 was developed primarily to combine good low temperature flexibility with acceptable thermal stability. This resin is almost universally used in coating glass cloth for the winding of Navy cables.

Dow Corning Silicone Varnish 997 is a new impregnating varnish which is said to be easily cured without bubbling in an air-circulating over at 300 to 400 F. The carefully graduated cure formerly required to assure a smooth, uniform film can be eliminated, according to the company, by using the new silicone varnish. Curing time is only 1/4 to 1/7 as long as the schedule recommended for earlier silicone varnishes. Improvements in curing time for 997 are described in relation to the earlier Silicone Varnish 996. This is the varnish which is most commonly used now in the building and rewinding of Class H equipment. Prior to the development of the new varnish, relatively long curing schedules have been one of the major deterrents in the use of Class H insulation on standard industrial motors. Now processing time for Class H equipment impregnated with 997 is comparable to the processing time required for Class B equipment. Curing temperatures, however, are still somewhat higher than those normally used for Class B equipment, but time is of primary consideration.

The third new resin, identified as Dow Corning Silicone Resin 2105, was designed for use in the production of silicone-glass laminates with superior dielectric properties. At 250 C, silicone-glass laminates made in company laboratories with 2105 had over 100 times the dielectric life of the best silicone-glass laminates previously available. Dielectric strength of glass laminates bonded with 2105 are shown below:

Dielectric Str., Volts per Mil
⅛-in. Thickness

ECC 116	*ECC 181*	*ESS 261*
Heat cleaned	Heat cleaned	Washed
310	300	250

Physical properties measured at room temperature on laminates made with 2105 are comparable to those of laminates made with Dow Corning 2103. The flexural strength of laminates made with 2105, however, decreases with increasing temperature, indicating a slight thermoplasticity. This charactertistic can be improved by curing at high temperatures. In any case, the decline in flexural strength at high temperatures is not considered to be great enough to limit the use of 2105 bonded laminates in most applications where maintenance of dielectric strength is important. Typical applications include transformer tubes used as ground insulation, barrier and terminal strips.

In addition to greatly improved dielectric strength, silicone-glass laminates made with 2105 should be considerably easier to produce. Experience indicates that catalyzed solutions of the new resin have a much longer shelf life than solutions of the earlier resin.

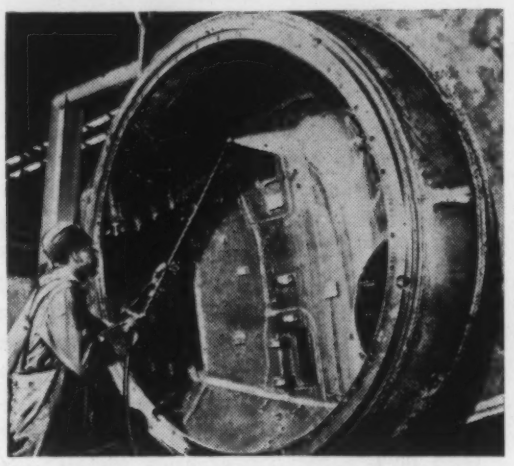
Three-in-One Phosphating Cleaner

Solo-Phos, a new solvent phosphating cleaner which is said to remove grease and tar, clean off chips and give a rust-inhibitive phosphate coating, has been developed by *Whitfield Chemical Co.*, 14225 Schaefer Highway, Detroit 27.

Used for one-step cold cleaning and phosphating of ferrous metals, aluminum and zinc, the cleaner reacts with organic or metallic soils. It has a high solvency for oil, grease and tar, and the rust-inhibitive film formed on metal surfaces is said to make an ideal base for painting.

Solo-Phos can be applied in concentrated form by spraying, flushing or dipping. Only standard equipment is necessary. After being allowed to react, it should be spray rinsed. Diluted solutions of the cleaner can be used hot or cold in tank or hand washing applications.

The product was developed primarily to be used on parts where heat is not available. It will not atack rubber-tired wheels, painted or plated surfaces, and can be applied over plastic coated parts. It is a viscous stable mild acid-solvent that is soluable in water. Its flash point is claimed to be above 200 F.



Phosphating cleaner removes grease and tar, cleans off chips, gives a rust-inhibitive phosphate coating.

Phenolic Molding Compound Has High Shock Resistance

Durez 16221 Natural, a new high-impact, glass-fiber-filled, one-step phenolic molding compound has just been announced by *Durez Plastics & Chemicals, Inc.*, Walck Rd., North Tonawanda, N. Y. The compound was formulated for applications where high shock resistance is required. Because of its mineral filler, it is claimed that it can be used at temperatures where cellulose-filled impact compounds would be unsatisfactory. It is said to have excellent dimensional stability and a high modulus of elasticity. These properties, in combination with the high strengths available, are expected to open new fields of application which heretofore required the use of metals.

The new compound is supplied in a dry, easy-to-handle form. It consists of impregnated fiber-glass rovings in 1-in. lengths. Other lengths are available upon request.

The material is readily molded by standard compression methods. Pressures of 5000 to 6000 psi are recommended. High-frequency preheating permits the use of lower molding pressures. Molding temperatures of 300 to 350 F are suggested, with the lower temperature most desirable for parts with thick sections. Cure time is only slightly slower than for general-purpose materials. A breathing cycle, where possible, is recommended.

Pipe Insulation Adaptable to Hot and Cold Temperatures

A new wrap-around pipe insulation, adaptable to hot and cold pipes of all sizes, has been added to the list of Fiberglas products manufactured by *Owens-Corning-Fiberglas Corp.*, Toledo 1. Known as Aerowrap, the new product is flexible and easy to apply on flanges, fittings and valves, as well as to hot and cold pipes of all sizes. It is a fine fibered insulating blanket with a special binder for use in industrial applications. It is soft and resilient and has a high heat-saving thermal efficiency.

Aerowrap can be used on pipes with temperatures ranging from sub-zero to 600 F, and can be applied in various degrees of thickness without difficulty by repeated wrapping. Its use as a wrap-around insulation for pipes is a broad step from the conventional practice of insulating hot or cold lines with rigid materials. Because of its compressibility and versatility, substantial savings can be made in storage and use of the material. After being wrapped around pipes the insulation can be kept in place by three different methods: with staples, with adhesive, or with Fiberglas cord tied on 6-in. centers. Then any one of four different kinds of jackets can be installed over the insulation. These are made of black roofing felt, white asbestos paper-faced felt, corrugated aluminum sheet, or rolled galvanized sheet metal. Jackets are held in place by wires, hands, staples or screws, depending upon the type selected.

The only special precaution said to be necessary for use of the insulation on cold pipe lines is the use of vapor-barriers to prevent condensation on cold pipe surfaces. Without a vapor barrier, moisture will penetrate insulation and condense on the pipe.

This new pipe insulation can be wrapped around easily to any desired thickness.

The new product is available in 100-ft rolls, 36 in. wide and ¾ in. thick. Pieces from the same roll can be used on different sizes of pipe for any thickness of insulation required and also on fittings.

New Materials and Equipment continued

Copper-Clad Hardenable Steel for High Conductive Spring Parts

A new high conductive spring material with spring properties said to be comparable to hardenable steel, has been announced by *Metals & Controls Corp., General Plate Div.,* Attleboro, Mass. The material is a composite metal consisting of a layer of medium-carbon steel with a relatively thin layer of electrolytic copper clad to one or both sides. The primary advantage of Comflex copper-clad hardenable steel is its low cost in comparison with hardenable copper alloy metals.

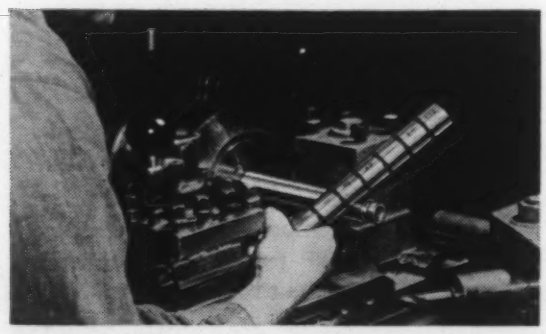
Other advantages claimed for the metal are high electrical and thermal conductivity, excellent ductility for extreme forming, good spring properties after heat treatment, resistance to corrosion, and ease of electroplating.

Flexibility in electrical conductive properties is obtained by varying the thickness of the copper layers. The material with a 10/80/10 thickness ratio is said to have a conductivity better than 30% when compared with solid copper.

The material is manufactured with the copper on one or both sides of the steel and in various thickness ratios—10/80/10 and 80/20 thickness ratios satisfy a majority of applications. Widths up to 8 in. and thicknesses from 0.050 in. down are readily available; other sizes can be produced if required.

The composite metal is supplied in a soft condition for fabrication. Spring characteristics are obtained by heat treating the parts. Hardening and tempering procedures are similar to those used for solid hardenable steel.

A few typical applications for the material are fuse clips, thin blade springs, electrical connectors, and pen and pencil clips.



The operator merely holds this specimen bar against his work to make a fast, accurate visual comparison check of surface roughnesss, waviness and lay.

Low Cost Method for Checking Surface Finishes

A new line of roughness comparison specimens, Surface Sticks, has been introduced by *Acme Industrial Co.*, 200 N. Laflin St., Chicago 7. These specimens are designed to meet the need for a low cost, yet practical, accurate means of determining smoothness or roughness of a surface.

Easy to use, the new product consists of various surface specimens individually finished to definite micro-inch readings and grouped together in handy finish-comparison bars. The operator merely holds the specimen bar opposite his work to make a fast, accurate visual comparison check of surface roughness, waviness and lay. Surface finishes can be instantly compared and checked for conformation to specifications, right at the machine.

The specimens can be furnished in approximately 1- by 1-in. round plug form, and in approximately 1- by 1½- by 1-in. rectangular blocks, in boxes accommodating three, five or eight assorted surface finishes.

High-Impact Resistant Plastics Offer Unusual Properties

New high-impact resistant plastics developed by *Bakelite Co.*, a division of Union Carbide and Carbon Corp., 122 E. 42nd St., New York 17, give strength to molded parts with thin cross sections and are also extruded in thin, tough sheets. Each of the three new formulations is said to have high impact resistance; to be easy to mold, extrude and machine; and to combine excellent electrical properties with the chemical resistance of Bakelite styrene plastic. The three grades have been designated as QMS-151, QMS-152 and QMS-155. Each grade varies slightly in the degree it includes these useful properties. For example, QMS-155 has the highest impact strength; QMS-151, best moldability.

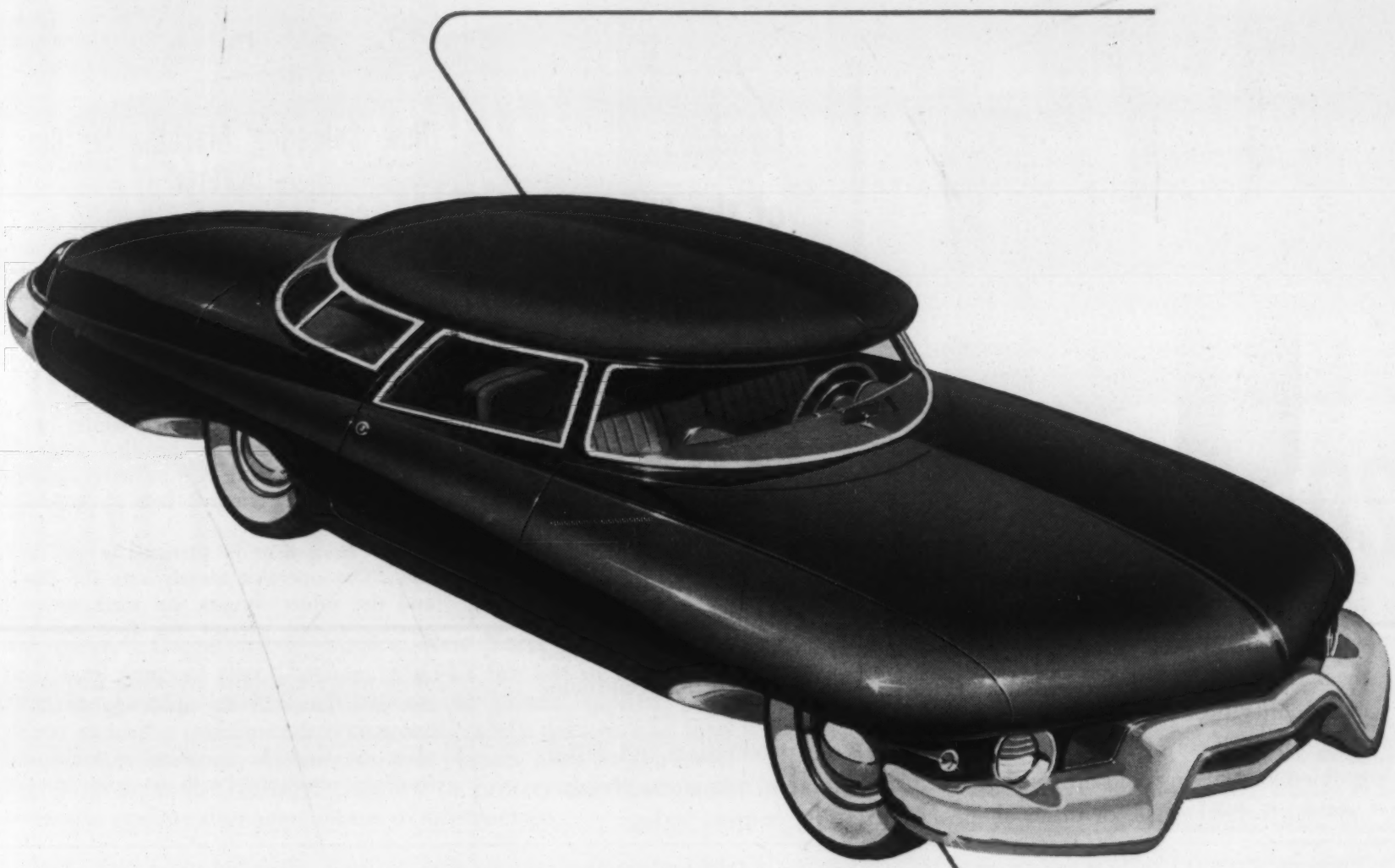
Extruded in sheets about 0.025 in. in thickness, 155 is tough and flexible as it emerges from the die. Such sheeting resists moisture, tearing and most chemicals. Sheets of the material are easy to post-form, swedge or blow to large shapes, such as refrigerator trays. Extruded sheet can be made in many colors with a mat finish or press polish, and takes printing easily.

The remarkable degree of impact resistance is demonstrated in new extruded tubing made of 155 and used in pipe and pipe fittings for farm water supply. Squeezed in a vise, 0.8-in. dia tubing with a wall thickness of 0.125 in. withstands a reduction of 70 to 80% in the jaw opening without cracking even down to —5 F. Pipe and pipe fittings made of 155 or 152 are also said to resist abrasion, and their aging and weathering characteristics appear similar to those of Bakelite styrene. Extruded in other shapes, the same high-impact materials make tough, rattan-like strips or strong wall moldings.

For injection molding of large pieces with thin cross sections, a third, general-purpose grade of rubber-modified Bakelite styrene plastic has been used with success. White refrigerator door liners, for example, are made of 151. The molded inner door panel weighs 5½ lb, measures 30 by 48 in., and has a minimum wall thickness of about 0.10 in. All three grades of the material can be injection molded in conventional molding equipment. As a comparison of moldability of these materials, minimum pressure to fill the mold is 10,000 lb psi for 151 and 14,000 for 155 for a 10-oz casting using the same injection cylinder temperature, mold temperature and length of cycle. Battery cases weighing 13 oz and refrigerator frames have also been injection molded from these materials.

(*More News on page 144*)

Specify N·A·X HIGH-TENSILE STEEL for Lighter Weight Longer Life with Economy



N-A-X HIGH-TENSILE, having 50% greater strength than mild carbon steel, permits the use of thinner sections—resulting in lighter weight of products. It is a low-alloy steel—possessing much greater resistance to corrosion than mild carbon steel, with either painted or unpainted surfaces. Combined with this characteristic, it has high fatigue and toughness values at normal and sub-zero temperatures and the abrasion resistance of a medium high carbon steel—resulting in longer life of products.

N-A-X HIGH-TENSILE, with its higher physical properties, can be readily formed into the most difficult stamped shapes, and its response to welding, by any method, is excellent. Due to its inherently fine grain and higher hardness, it can be ground and polished to a high degree of lustre at lower cost than can mild carbon steel.

Your product can be made lighter in weight . . . to last longer . . . and in some cases be manufactured more economically, when made of N-A-X HIGH-TENSILE steel.

KEEP YOUR SCRAP MOVING TO YOUR DEALER

MAKE A TON OF SHEET STEEL GO FARTHER Specify— N·A·X HIGH-TENSILE STEEL ... And "MAKE YOUR PRODUCT LAST LONGER"

GREAT LAKES STEEL CORPORATION

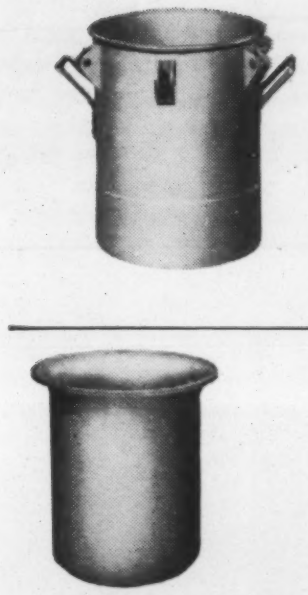
N-A-X Alloy Division • Ecorse, Detroit 29, Michigan

NATIONAL STEEL CORPORATION

Prest-O-Lite
Trade-Mark

Cold-Drawn SHAPES and SHELLS

made to your specifications by *Linde*



Leaders of the Field for Almost Half a Century

PREST-O-LITE cold-drawn shapes and shells can be quickly and economically produced to your most rigid specifications—from 1½ to 23 inches in diameter and up to 50 inches in depth. Our greatly expanded, well-equipped plant has every modern manufacturing facility and is manned by a thoroughly experienced, highly specialized staff—prime requisites of a quality product.

LINDE engineers will gladly help you solve your production and design problems involving cold-drawn shells, cups, containers, receivers, pressure vessels, formed parts, or other shapes. Mail us the coupon today.

The term "Prest-O-Lite" is a trade-mark of Union Carbide and Carbon Corporation.

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Linde Air Products Company 542
30 East 42nd Street
New York 17, N. Y.

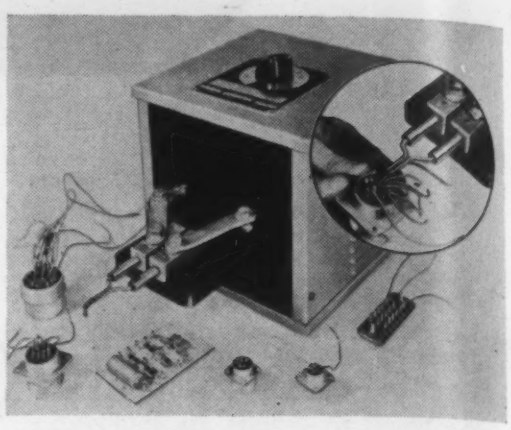
Please send complete information about cold-drawn shapes and shells.

NAME_____

COMPANY_____

ADDRESS_____

New Materials and Equipment



New Soldering Machine for Connectors

Joyal Products Inc., 56 Belmont Ave., Newark 3, N. J., has announced the availability of its new 250 W.—AN Connector Soldering Machine. The unit is said to be able to solder from two to 30 terminals and more on AN connectors.

It can also be used on terminal boards, on printed circuits with high temperature solder that cannot be handled with a soldering iron, and for military equipment on solder-crimped lugs to government specifications.

The equipment is particularly easy to use. The operator merely sets the heat and the solder, brings the work to the electrodes and presses the foot switch. The electrodes can reach into the tiniest areas where a regular soldering iron cannot penetrate. In the soldering of AN connectors, the machine is said to complete the work in one-third of the time formerly consumed, with no cold joints.

Heat Transfer Medium for Normalizing Nylon

Glycowax S-932, a synthetic wax, is currently being offered by *Glyco Products Co., Inc.*, 26 Court St., Brooklyn 2, N. Y., for use as a heat transfer medium for normalizing molded nylon parts. The wax (melting point 140 to 147F) is stable over the heat range required, does not attack nylon, has a high smoke point (about 500 F) and a high flash point (about 620 F).

The heat treating bath is, preferably, electrically heated and thermostatically controlled at the desired temperature of 350 F. For handling a large quantity of

HILLIARD SLIP CLUTCHES

BUILT WITH MEEHANITE CASTINGS

The Hilliard Corporation—Elmira, New York, manufacture a line of all-purpose slip clutches (Fig. 1) for use in equipment requiring precise control of tension or power applied to a driven machine and in connection with safety devices and load limiting mechanisms. As an example, planers such as shown in Fig. 2 incorporate Hilliard clutches to protect the heads and crossrails against damage in case of obstruction.

Such clutches obviously require component castings which can provide without fail three definite characteristics—namely:

1. **High tensile strength**
2. **Resistance to heat deterioration**
3. **Maximum wearing qualities**

Hilliard designers specify Meehanite castings for all cast parts of this clutch on the basis of experience and the sure knowledge that these properties will be secured regularly.

In addition the use of Meehanite castings gives an assurance of uniformity, ready machinability, and a high freedom from casting defects. Thus production flows are steady and efficient and Quality of the product high.

For facts about how Meehanite castings can improve *your* product, reduce losses and speed production, write for Bulletin #35—"Meehanite Castings Serve All Industry".

Take *YOUR* Casting Problem To A MEEHANITE FOUNDRY

American Brake Shoe Co.	Mahwah, New Jersey
The American Laundry Machinery Co.	Rochester, New York
Atlas Foundry Co.	Detroit, Michigan
Banner Iron Works	St. Louis, Missouri
Barnett Foundry & Machine Co.	Irvington, N. J. & Dover, N. J.
E. W. Bliss Co.	Hastings, Mich. and Toledo, O.
Builders Iron Foundry	Providence, Rhode Island
Compton Foundry	Compton, Calif.
Continental Gin Co.	Birmingham, Alabama
Crawford & Doherty Foundry Co.	Portland, Oregon
The Cooper-Bessemer Corp.	Mt. Vernon, Ohio, and Grove City, Pa.
De Laval Steam Turbine Company	Trenton, New Jersey
M. H. Detrick Co.	Newark, N. J. & Peoria, Ill.
Empire Pattern & Foundry Co.	Tulsa, Oklahoma
Farrel-Birmingham Co., Inc.	Ansonia, Connecticut
Florence Pipe Foundry & Machine Co.	Florence, New Jersey
Fulton Foundry & Machine Co., Inc.	Cleveland, Ohio
General Foundry & Manufacturing Co.	Flint, Michigan
Greenlee Foundry Co.	Chicago, Illinois
The Hamilton Foundry & Machine Co.	Hamilton, Ohio
Hardinge Company, Inc.	New York, New York
Hardinge Manufacturing Co.	York, Pennsylvania
Johnstone Foundries, Inc.	Grove City, Pennsylvania
Kanawha Manufacturing Co.	Charleston, West Virginia
Koehring Company	Wilwaukee, Wisconsin
Lincoln Foundry Corp.	Los Angeles, California
London Concrete Machinery Co., Ltd.	Brantford, Ontario
E. Long Ltd.	Orillia, Ontario
Otis Elevator Co., Ltd.	Hamilton, Ontario
The Henry Perkins Co.	Bridgewater, Massachusetts
Palmyra Foundry Co., Inc.	Palmyra, New Jersey
Pohlman Foundry Co., Inc.	Buffalo, New York
Rosedale Foundry & Machine Co.	Pittsburgh, Pennsylvania
Ross-Meehan Foundries	Chattanooga, Tennessee
Shenango-Penn Mold Co.	Dover, Ohio
Smith Industries, Inc.	Indianapolis, Ind.
Standard Foundry Co.	Worcester, Massachusetts
The Stearns-Roger Manufacturing Co.	Denver, Colorado
Traylor Engineering & Mfg. Co.	Allentown, Pennsylvania
Valley Iron Works, Inc.	St. Paul, Minnesota
Warren Foundry & Pipe Corporation	Phillipsburg, New Jersey

"This advertisement sponsored by foundries listed above."

MEEHANITE® NEW ROCHELLE, N. Y.

Perhaps the most interesting feature of this Duraspun High Alloy Casting is that four different sizes of centrifugal castings are involved. These vary from 34" to 3½" in diameter. Sections, outlets, collar bands, lugs etc., were all welded together in our shop to form the retort as you see it in the picture. Assembled weight runs around 7,464 pounds.

High alloy castings is our business—not merely the adjunct of an extensive steel founding business. We have the experience — 30 years in the static casting division and 20 years on centrifugal castings. We pioneered both kinds of castings in this country. And we have excellent testing and checking facilities, including a 400,000 volt X-ray machine and gamma-ray units.

If you would like this combination of wide experience, modern shop practice, up-to-date equipment and full testing facilities working on your next high alloy casting, bring it to us.

THE DURALOY COMPANY

Office and Plant: Scottdale, Pa. • Eastern Office: 12 East 41st Street, New York 17, N.Y.

Detroit Office: 23906 Woodward Avenue • Pleasant Ridge, Mich.

Atlanta: J. M. TULL Metal & Supply Co. Chicago: F. O. NELSON 332 S. Michigan Avenue San Francisco: JOHN D. FENSTERMACHER 1241 Taylor Street

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New Materials and Equipment

small items, a wire basket fitted with a lid to prevent the nylon from floating is suggested. The wire basket is then immersed in the heat treating bath. Minimum immersion time for heat treating articles having a wall thickness of less than 1/8 in. is 10 min. For articles of heavier cross section, up to 30 min. may be required.

After immersion, the basket is removed and allowed to drain. The wax is said to give good run-off, and only a very thin film remains on the nylon parts. The treated parts are then placed in an insulated box, away from a draft, and allowed to cool.

Removal of the thin film of the wax is usually unnecessary. If removal is necessary, then parts, having first been cooled, are again placed in a wire basket and immersed in water at the boiling point for approximately 1 min. The wax floats to the surface and can be skimmed or drawn off. This short period of heating is not sufficient to set up new stresses or strains in the nylon parts.

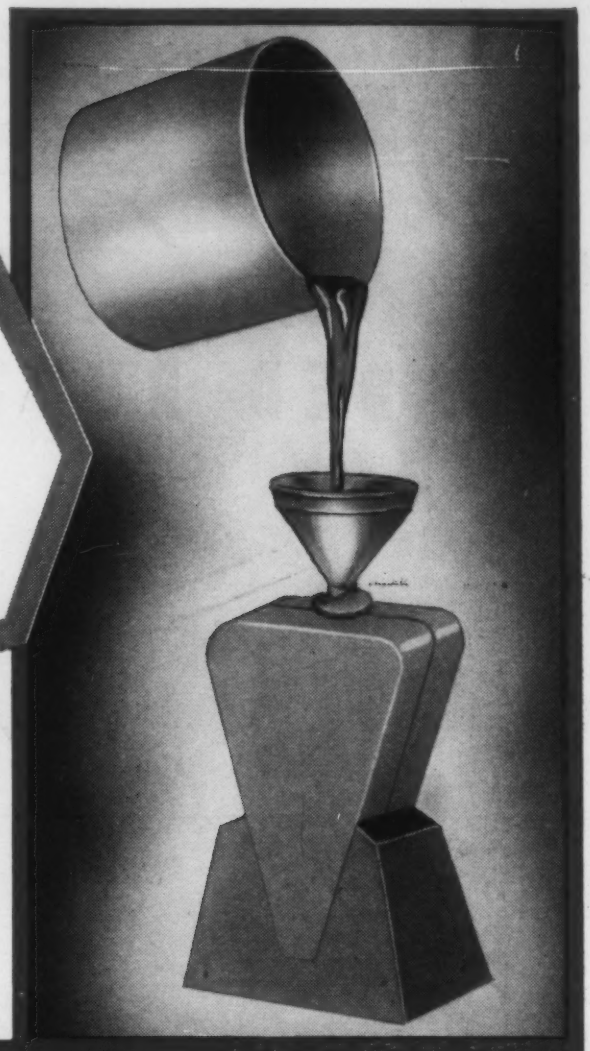
Neoprene Painting System Effects Savings in Costs

The Pennsylvania Salt Manufacturing Co., 1000 Widener Bldg., Philadelphia 7, has announced a new system of anti-corrosion coating using specially formulated Neoprene coatings. According to the company, the new system has resulted in savings up to 50% per sq ft in the maintenance painting and coating costs in the company plants.

The special formulations are NeoCoat and NeoPrime A (for all surfaces except concrete) and NeoPrime B (for concrete surfaces). NeoCoat is a true plastic, involving polymerization, in which the accelerator is included in the product, thus eliminating the necessity of mixing on the job. The polymerization takes place after the coating is applied. The special formulation of the coating was developed as a result of the company's tests and experience in its own plants. In these tests, it was found that to stand up in service, a coating had to be built up to a thickness of at least 5 mils—regardless of its corrosion resistance—and had to be especially effective in covering welds, beads, seams and edges where coatings most frequently failed. It was also found that it is uneconomical, from the labor and time standpoint, to apply more than three coats, including the

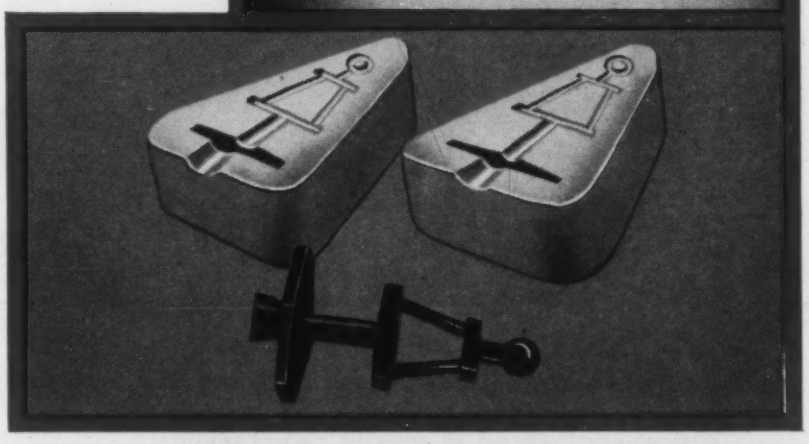
COLD CASTING WITH

Thiokol* LIQUID POLYMER LP-2



A pourable liquid that converts to a rubber at room temperature

WITHOUT SHRINKAGE



The cold casting compound shown here is made by the Perma-Flex® Mold Co., Columbus 9, Ohio. Thiokol Corporation supplies LP-2 only as a raw material. Because of its desirable properties, "Thiokol" LP-2 was selected as the elastomer for their line of flexible molding pattern compounds.

Unlike other rubbers and latices, "Thiokol" LIQUID POLYMER LP-2 is a solventless liquid that is poured and cured cold and does not undergo dimensional change during handling. It cures to a rubber with the following properties:

- **Dimensional stability for an indefinite period**
- **Inertness to water, most oils and solvents, mild acids and alkalis**
- **Toughness and resilience**
- **Stability and flexibility over a broad temperature range**
- **Inertness to ozone, sunlight and aging**

The application shown here illustrates the ease of casting "Thiokol" LIQUID POLYMER LP-2 at room temperature. In this manner intricate cavities are permanently filled with a flexible rubber that conforms exactly to the shape of the cavity or mold walls.

The room temperature pourability of "Thiokol" LP-2 coupled with the desirable properties it displays as a cured elastomer have led to the successful application of this versatile polymer in other fields such as sealing, caulking and filleting.

Thus, "Thiokol" LP-2 is now widely used for sealing integral fuel tanks and pressurized cabins in aircraft; for caulking ship decks; for filleting glass and plastics in combination with other materials; and for casting gaskets and seals in place on various types of machinery.

In all of these applications, "Thiokol" LP-2 simplifies production methods and yields desirable product characteristics. Similarly, "Thiokol" LP-2 may yield parallel advantages in your product or process.

Thiokol CORPORATION

Our technical personnel will be glad to discuss the feasibility of employing "Thiokol" LP-2 in any application you have in mind.

*Thiokol, Reg. U.S. Pat. Off.
Ptd. in U.S.A.

784 NORTH CLINTON AVENUE, TRENTON 7, NEW JERSEY

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ACUSHNET specializes in "precision" molded rubber parts custom-engineered to specific requirements.

Utilizing the most modern techniques, our Engineering Staff constantly is developing new approaches to old problems, with notably successful results. By ingenious mold designing and skillful compounding, yesterday's skepticism of rubber for certain uses has changed to complete confidence in this versatile material as ideal for applications in countless vital assemblies.

Acushnet
PROCESS COMPANY

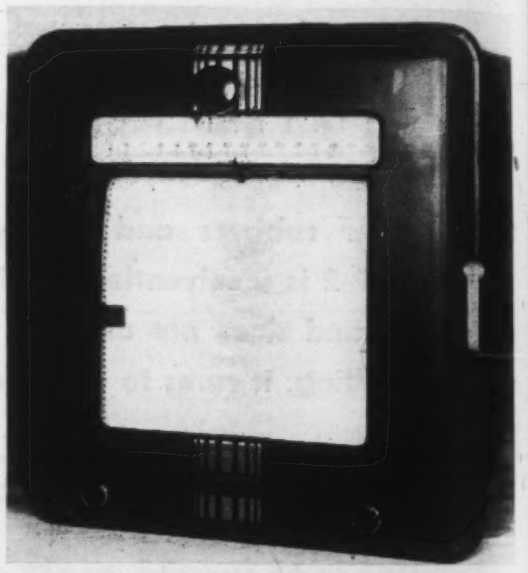
Consult our engineers on your next precision molded rubber job. In the meantime, send for a copy of the "Acushnet Rubber Handbook", a comprehensive rubber data reference for molded rubber parts.

Address all communications to 750 Belleville Ave., New Bedford, Mass.

New Materials and Equipment

primer. Therefore, NeoPrime and Neo-Coat were formulated to attain the proper thickness within three coats.

In a number of cases, it was reported that the overall initial cost of using the new system appeared to be higher than other methods; but measured against maintenance painting costs over several years, the new system was about half that of other systems.



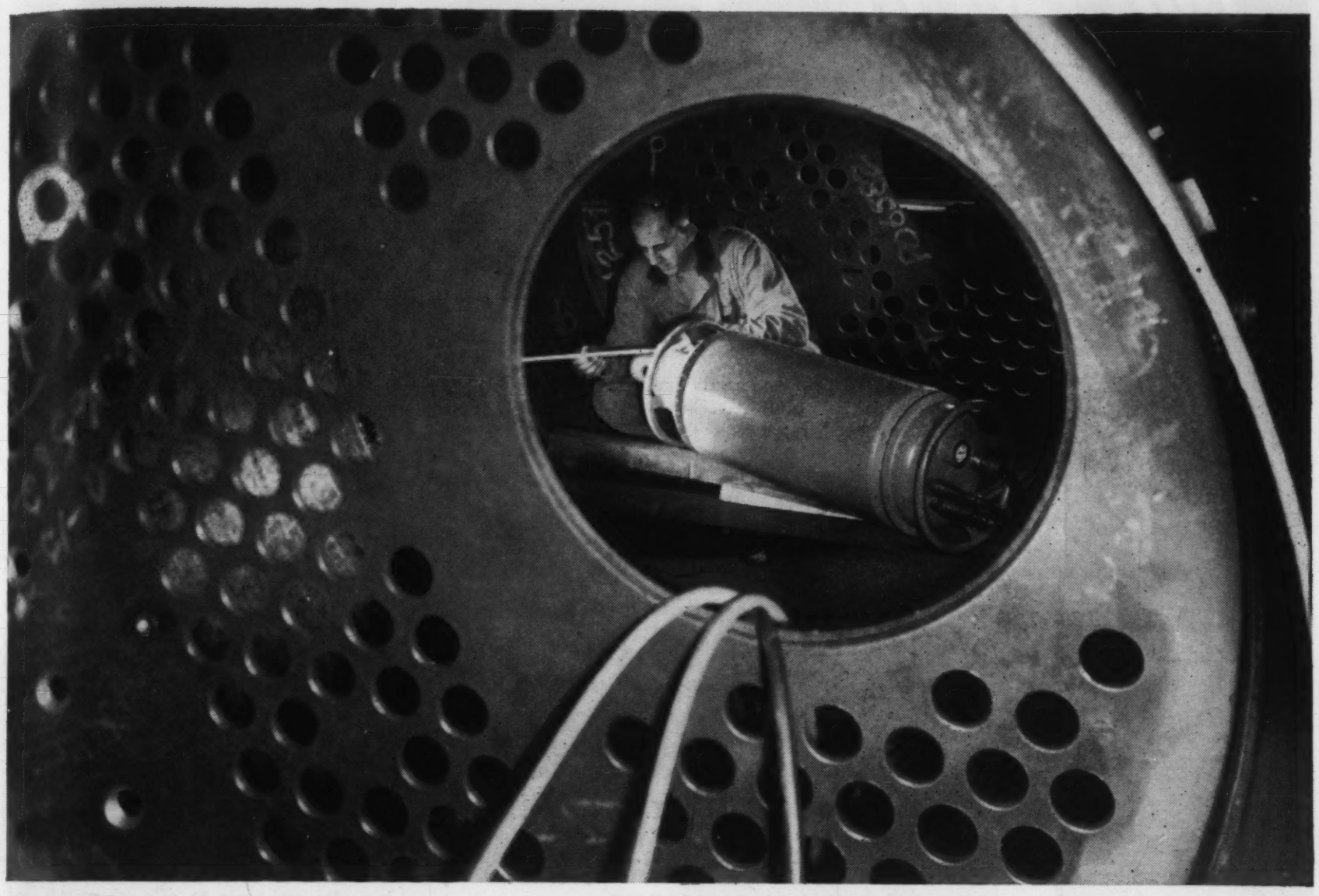
Temperature Recorder and Difference Controller Combined in One Unit

Accurate reversal of regenerative furnaces is now said to be obtained with a new combined temperature recorder and temperature difference controller offered by *Leeds & Northrup Co.*, 4934 Stenton Ave., Philadelphia 44. The controller provides in one instrument—instead of the conventional two—continuous recording of checker temperature, simultaneous measuring of temperature-difference between regenerators, and either automatic furnace reversal or warning for manual reversal when pre-set difference is reached. According to the company, this marks the first time such a combined instrument, in which these furnace factors can be recorded, analyzed and regulated, has been offered to users of regenerative furnaces and glass tanks.

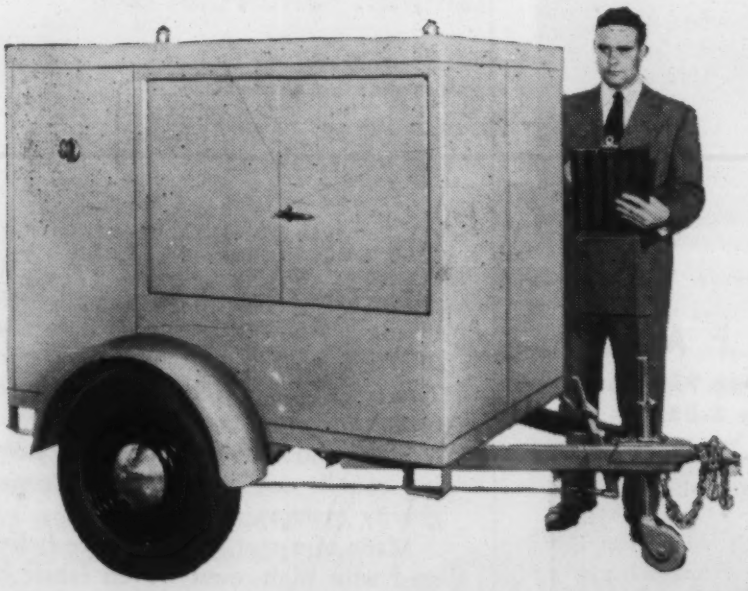
The controller draws a two-point continuous line record of the temperature of checkers at opposite ends of the furnace. It does not record temperature difference as such, but plots a record of high and low temperatures, with the width of the

NOW — a *truly* portable industrial x-ray unit!

The General Electric RESOTRON 250



Compact, lightweight, 250,000-volt x-ray unit speeds inspection of large structures, saves many hours of set-up time



For radiographic examination of welds or castings in large structures, the new GE Resotron 250 offers unprecedented advantages. Completely housed in a cabinet only 4 x 6 x 4-foot high, which may be trailer-mounted, this unit can be set up anywhere in a few minutes by one or two men.

Small, lightweight tube head can be passed through a 15-inch diameter opening for interior inspection of large vessels. It's particularly adapted for ship hulls, pressure vessels, steam pipes. No cranes or elaborate rigging needed — can be manipulated manually.

Resotron 250 is the latest addition to the complete GE line of industrial x-ray apparatus . . . ranging up to 2,000,000-volt units and betatrons. It is actually a miniature of the famous General Electric million-volt Resotrons, with such time-proven features as resonant transformer, cascade tube and gas insulation.

Have you inspection problems the Resotron 250 might solve? See your local GE x-ray representative. Or write X-Ray Department, General Electric Company, Milwaukee 1, Wis., Rm. AZ-4.

GENERAL ELECTRIC

It's the Finish that Counts

ROTO FINISH

Roto-Finish COMPOUNDS AND CHIPS ARE MADE TO GIVE YOU THE PROPER FINISH ECONOMICALLY

There are other brands of materials that resemble Roto-Finish chips and compounds . . . but only Roto-Finish chips and compounds give you the *extra advantage* of continuous research by the company who originated the Roto-Finish processes. Roto-Finish chips and compounds are carefully manufactured so *you* obtain the best results on *your specific job*. To obtain the best results at the lowest cost . . . insist on ROTO-FINISH chips and compounds.

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SAVES MAN HOURS AND MONEY by eliminating hand finishing.
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Put the experience and facilities of Roto-Finish to work for you on *your special finishing problems.*

Send a few unfinished parts to us . . . plus a finished part as a guide. We *guarantee* that you will get the same results in your plant that we produce in our laboratory. There's no obligation.

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Roto-Finish COMPANY

associated with The Sturgis Products Co.
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New Materials and Equipment

recorded band between them showing temperature-difference.

The unit is available for use with either thermocouples or Rayotube detectors. It can be used in a complete company "packaged" reversal control system, or tied-in with other reversal equipment.

Insulating Varnish for High-Speed Rotating Equipment

A new electrical insulating varnish, designed especially for equipment where high speeds and/or intense vibration normally would cause wire movement and resultant electrical failures, has been announced by *Irvington Varnish and Insulator Co.*, 6 Argyle Terrace, Irvington 11, N. J. Known as Irvington #140, the new varnish is said to have outstanding mechanical strength even at Class B temperatures.

Although the new product was specifically formulated to meet exceptional standards of mechanical strength, its other qualities are also claimed to be outstanding. Its resistance to oils, chemicals and moisture is said to be equal to the best obtainable. Its electrical properties are considered to be excellent, and its storage and dip tank life exceptional. Another feature of the new varnish is the fact that inexpensive naphtha can be used for thinning, thereby cutting down solvent costs.

Low-Cost Flexible Tubing Offered

Flexflyte Green Label, a new low-cost tubing for a wide range of industrial applications, has been anounced by *Flexible Tubing Corp.*, Guilford, Conn. Intended for such applications as air handling, fume removal and dust collection, the new tubing can be used in exhaust, blowing or gravity systems.

Made of a rust resistant wire helix covered with high-count woven fabric coated with a tough resinous compound, Flexflyte is a light weight tubing with a relatively smooth bore and negligible reduction of cross-sectional area in tight bends. It is

Economical protection that is built . . . NOT APPLIED

AMPCOFLEX® is an unplasticized, rigid polyvinyl chloride. It is corrosion-proof all the way through . . . and self-supporting as well. It has no coating to wear with time . . . nor edges or under-surfaces that ever become exposed and corrode. AMPCOFLEX Fabrications provide you with the long-term, economical solution to many industrial corrosion problems.

While only one-half the weight of aluminum, AMPCOFLEX has a tensile strength of 9000 psi at 75° F. It is inert to most acids, salts, alkalies and standard pickling and plating solutions.

One of the more important uses of AMPCOFLEX is for fume exhaust systems. Here, additional properties of impermeability, high dielectric strength and low fluid friction factor are definite advantages.

AMPCOFLEX . . . *plus ATLAS specialized experience and fabrication facilities*

The success and long life of a corrosion-proof structure depends on *both materials and construction techniques*. For this reason, ATLAS has developed complete fabrication facilities for AMPCOFLEX. ATLAS shops will produce any item from small trays to large tanks and complete exhaust systems fabricated of unplasticized, rigid polyvinyl AMPCOFLEX. In addition, ATLAS will furnish necessary pipe, pipe fittings and accessories.

For Complete Data, write for Bulletin 9-1.
ATLAS MINERAL PRODUCTS CO.
MERTZTOWN, PENNA. • Houston 1, Texas

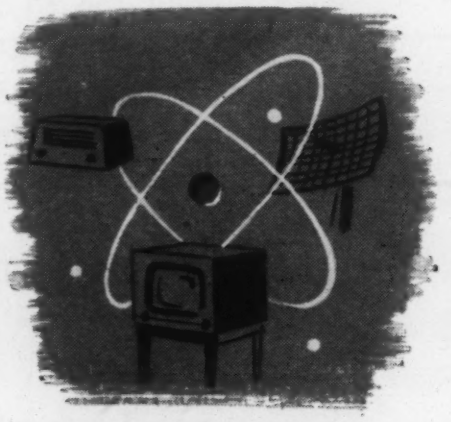
. . . self-supporting, corrosion-proof structures

ATLAS Ampcoflex FABRICATIONS

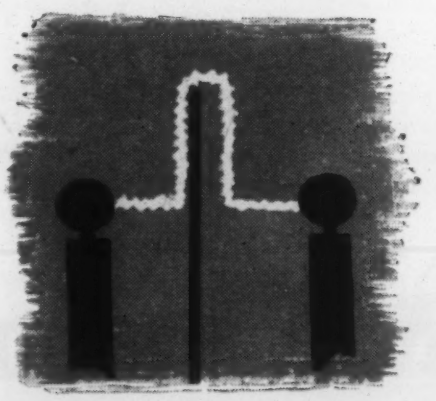
Formica

for new ideas in laminated plastics

PRINTED CIRCUITRY
Formica copper-clad laminates make intricate electrical assemblies smaller, lighter, more reliable.

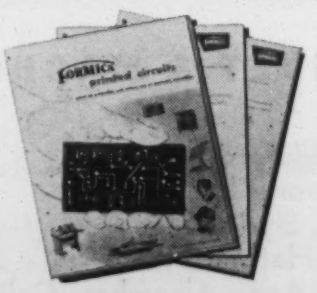


FF-33 fibreglass fabric grade impregnated with arc-resistant resin for excellent low loss electrical properties, dimensional stability and long, dependable service at high temperatures.



MF-41 fibreglass mat grade impregnated with melamine resin for electrical applications requiring high flame resistance and relatively high arc resistance.

FOR FAST FACTS . . . CLIP COUPON



The Formica Co.
4678 Spring Grove Ave.
Cincinnati 32, Ohio

Send us information immediately on

☐ Printed circuits
☐ FF-33 ☐ MF-41

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Address _____

DON'T get your neck in a NOOSE!

Use Milford's scientific approach to your fastening problem.

If you were solely responsible for recommending a machine tool for your company's production needs, you'd make pretty certain that your choice would perform correctly, efficiently, with the lowest possible dollar expenditure. Right?

It's important, too, to do likewise in recommending fasteners, and functional components that may be cold-headed. Millions of dollars yearly are wasted by not giving these parts . . . at the design stage . . . the same careful scrutiny that is given major production equipment.

Why not consult our cold heading engineers before designs are "frozen" . . . while planning is fluid enough to save you excessive costs?

EST. 1919

MILFORD

the name to rivet in your memory for fasteners

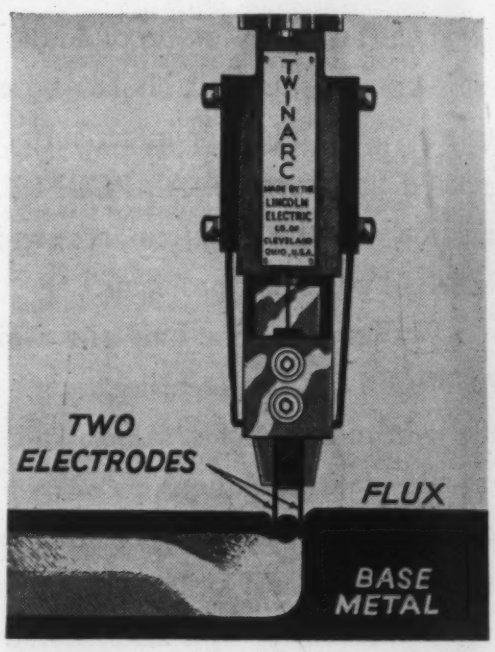
THE MILFORD RIVET & MACHINE CO.

859 Bridgeport Ave., Milford, Conn.
834 Illinois Ave., Aurora, Ill.
1110 W. River St., Elyria, Ohio
30 Platt Street, Hatboro, Penn.
721 So. Palm Ave., Alhambra, Calif.

New Materials and Equipment

said to have good resistance to oils, gases, acids, alkalies and abrasion. It has good aging qualities, and is flame resistant.

The tubing is stocked in 50-ft lengths, from which any desired shorter lengths can be cut. Soft cuffs can be produced by removing part of the supporting wire helix at each end. The product is available in diameters from 1 to 2½ in., in ½-in. increments.



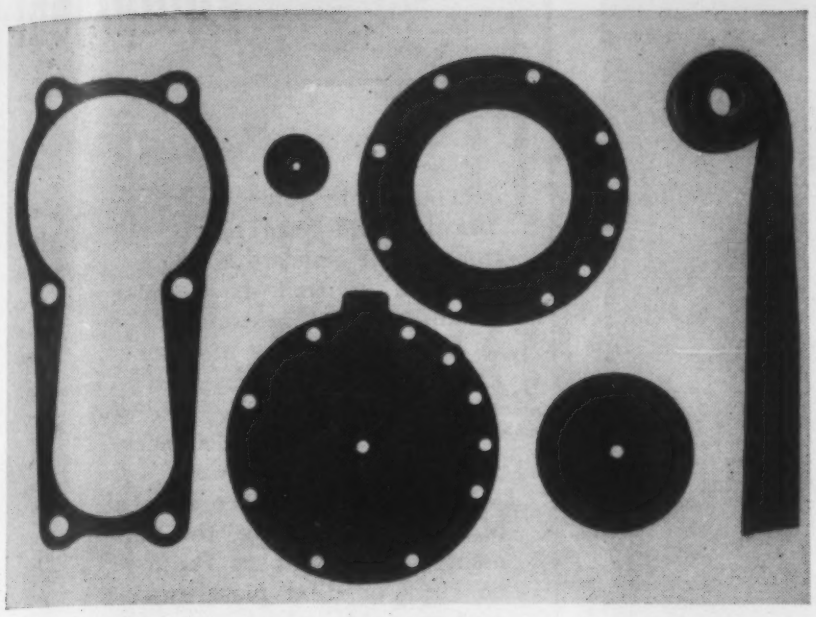
Submerged Arc Welding Development Increases Welding Speeds

A new development in the application of hidden arc or submerged arc welding has been announced by *The Lincoln Electric Co.*, Cleveland 17, and is said to increase the speed of automatic welding from 50% up. Twinarc welding, as the development is called, employs two small electrodes in place of a single larger electrode. The two electrodes are fed simultaneously through a single head and a single jaw. Both electrodes deposit metal in the weld crater. The higher currents possible with two electrodes increase the rate of metal deposition, amount of penetration and, consequently, welding speeds.

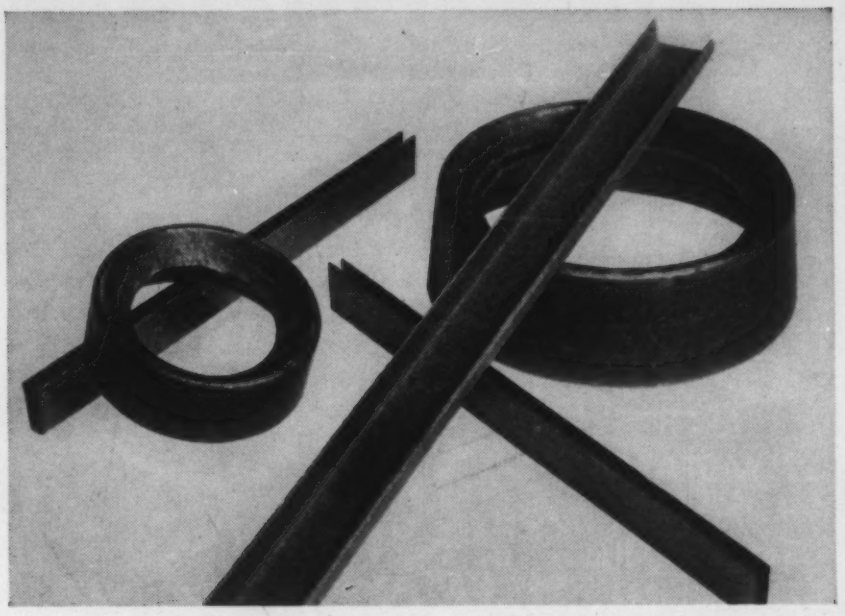
Twinarc welding is recommended for use on butt or fillet welds in ¼-in. or thicker plate where the application is normal for automatic submerged arc welding. Typical of the speeds possible is that used in making a ¾-in. fillet weld, 15 in. per min at 1500 amp.

A special electrode jaw, wire feed

Are any of these problems yours?

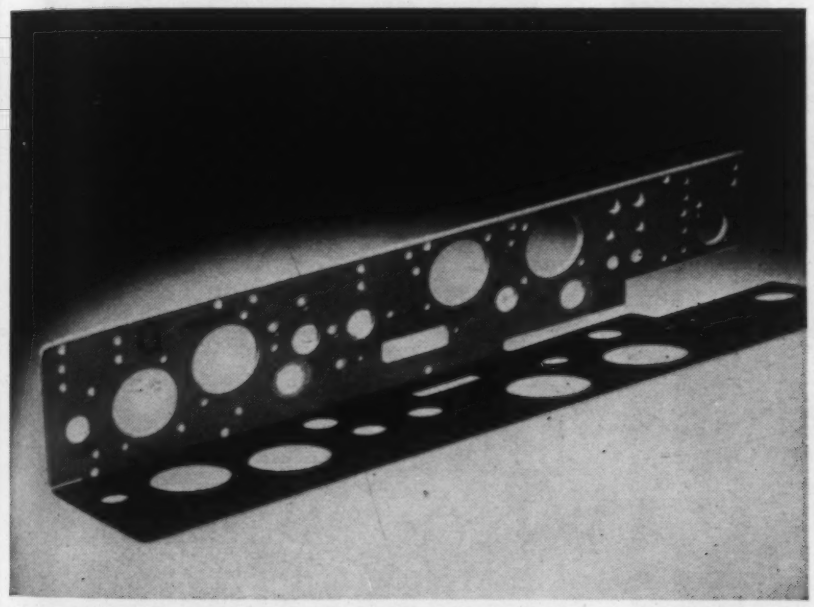


1. Need rubber-like properties for long periods of time under extreme temperatures? EMPIRE® Silicone Rubber Coated Glass Cloth (Class H insulation) is suitable for use over a temperature range of —70° F to 400° F . . . is resistant to thermal shock . . . will not crack, become brittle or deteriorate at high or low temperatures . . . offers good resistance to lubricating oils and most chemicals . . . has good dielectric strength and low power factor.

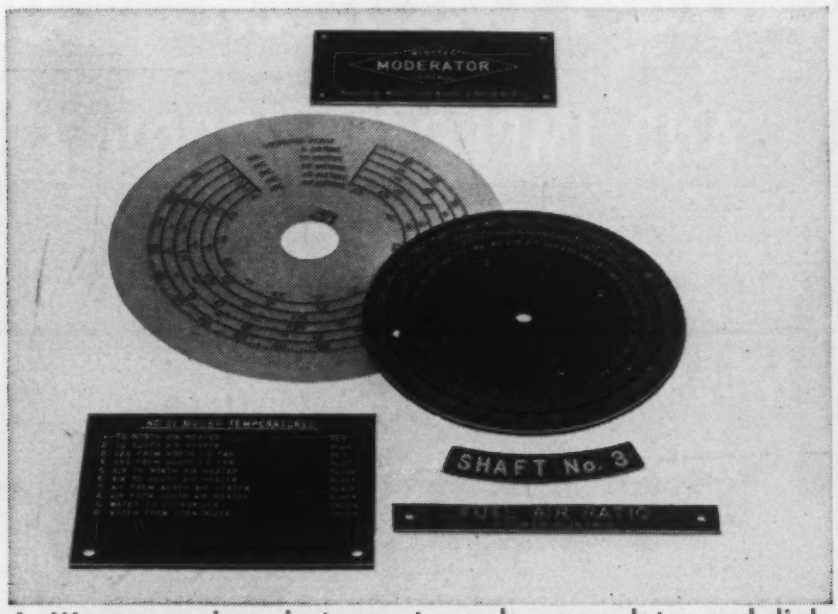


2. Looking for molding plate for Class H installations? Silicone molding plate for Class H applications which could not be produced successfully with regular built-up mica splittings can now be manufactured from ISOMICA* (built-up continuous mica sheets). ISOMICA silicone bonded molding plate has excellent moldability...excellent retention of shape...and an extremely high degree of homogeneity.

*Trade-mark



3. Looking for a versatile material with special mechanical, electrical and structural properties? LAMICOID®—a laminated plastic made with various fillers—is available in standard NEMA grades and others, with characteristics such as punching adaptability, heat and moisture resistance, tensile strength, impact strength, low loss factor, high dielectric strength, and properties "custom-made" to your specifications.



4. Want your signs, instrument panels, nameplates and dials to look better, last longer, be easier to install and maintain? DECORATIVE LAMICOID lends itself readily to marking by engraving, sandblasting, silk screen and rubber-plate printing, painting, filling or use of printed matter. Resists wear, aging, weathering, oils, corrosive vapors, moisture and temperature extremes. Wipes clean with a damp cloth.

Whatever electrical insulating materials you need, MICO makes them best. We manufacture all standard types and many special materials, or fabricate parts to your specifications. Send us your blueprints or problems today.

1893-1953 60 Years of Leadership in Electrical Insulation

MICO ELECTRICAL INSULATION

MICA *Insulator* COMPANY

Schenectady 1, New York

Offices in Principal Cities

LAMICOID® (Laminated Plastic) • MICANITE® (Built-up Mica) • EMPIRE® (Varnished Fabrics and Paper) • FABRICATED MICA • ISOMICA*

VELVAGLAZE

MONARCH VELVAGLAZED DIE CASTINGS USED ON THE GENERAL ELECTRIC CANNISTER CLEANER

Cuts Finishing Costs...

AND IMPROVES PRODUCT QUALITY

Velvaglaze is now used by leading manufacturers to obtain a more durable, brighter surface finish that improves product sales appeal. Velvaglaze resists scratching and marring experienced on normal cast aluminum surfaces.

Velvaglaze is available exclusively on Monarch aluminum Permanent Mold castings and aluminum Die Castings. Investigate the substantial savings you can obtain over other comparable fine finishing methods using Monarch Velvaglaze castings.

WRITE TODAY FOR FREE BROCHURE

"Here's How You Can Cut Die Casting Finishing Costs"

- Aluminum Permanent Mold
- Aluminum Die Castings
- Certified Zinc Die Castings
- Complete Product Assembly
- Every Modern Finishing Service

Detroit Ave. at W. 93rd St., Cleveland 2, Ohio

New Materials and Equipment

rolls and wire guides adapt any standard Lincoln weld head for using two electrodes. The standard single head controls are used as well as the standard d.c. welding current generators. Currents up to 1500 amp can be used for which two generators may be paralleled or a single 1500-amp unit can be used. The two-wire head will feed electrodes in 5/64-, 3/32- and 1/8-in. dia sizes.

In addition to increasing the speed of automatic welding, the new development is also said to facilitate welding on rusty or dirty plate, producing high quality welds where normal single arc technique would result in pin holes.

New Solder Eliminates Many Difficulties

A new solder in paste form, Eutec-Tinweld, has been introduced by *Eutectic Welding Alloys Corp.*, 40-40 172 St., Flushing, N. Y. According to the company, the new product is claimed to eliminate all soldering difficulties and to reduce the number of operations to two—painting on the paste and applying the heat.

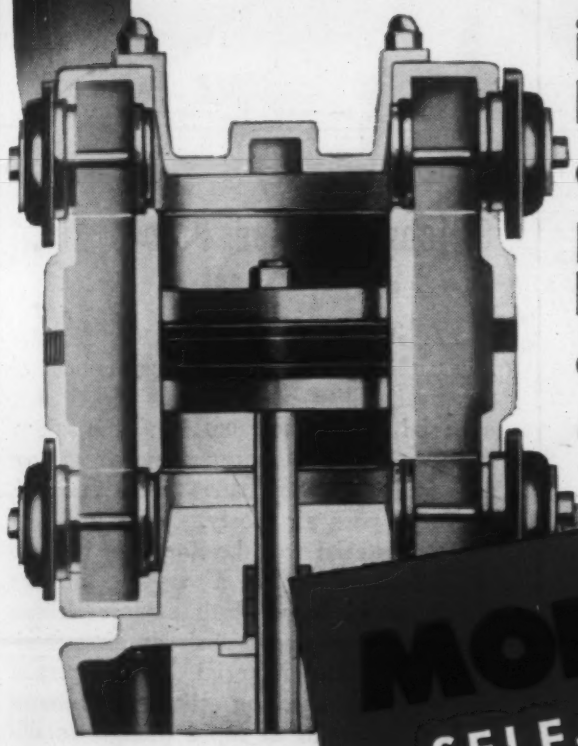
Technically, the material has extremely thin flowing properties, with the solder so carefully balanced with its accompanying flux that the high wettability and capillary action permit it to penetrate the tightest of joints.

The parts to be joined are painted with the solder-paste and when heat is applied, TinWeld becomes a liquid. When the liquid darkens, it is a sign that the soldered joint is complete. There are

Prevent Contamination

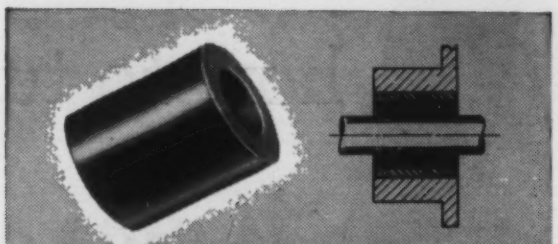
PROTECT PURITY—

in compressors handling foods, chemicals, plastics, beverages, oxygen, etc.

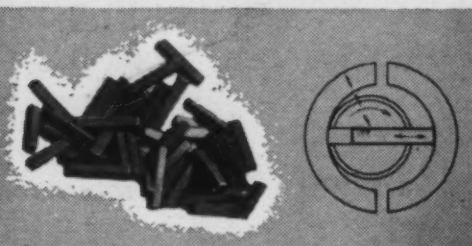


MORGANITE SELF-LUBRICATING PISTON RINGS

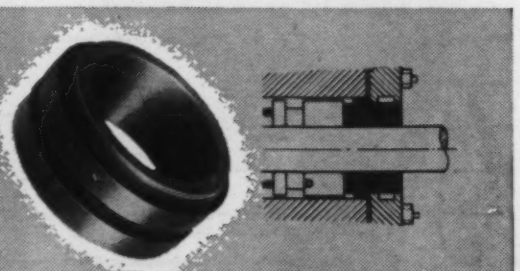
Require no lubricant during the life of the ring . . . completely efficient lubrication is inherent in the rings themselves. This "built-in" lubrication employs no impregnations . . . imparts no taste or odor, will not contaminate. Because oiling is unnecessary, maintenance is reduced and operating costs are lower. Morganite Self-Lubricating Rings are the practical solution for compressors in oxygen and other hazardous service.



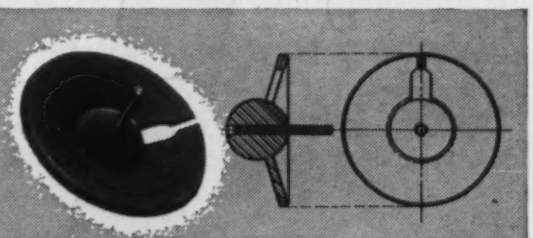
● **MORGANITE SELF-LUBRICATING BEARINGS** — Non-contaminating, unaffected by chemicals and most acids. Operate efficiently at relatively high speeds and temperatures. Recommended for pumps, mixers, grinders, agitators, food and enameling oven conveyors and general industrial service.



● **MORGANITE BLADES FOR REFRIGERATION COMPRESSORS**—Self-lubricating, non-gumming, corrosion resistant, and immune from warping. Prevent sticking and eliminate chemical deterioration of the compressor blades . . . effecting substantial savings on maintenance and replacements.



● **MORGANITE SELF-LUBRICATING CARBON SEALS**—Recommended for pumps, agitators, mixers and other equipment handling liquids including corrosives. The self lubricating feature is especially valuable where inaccessibility makes maintenance difficult.



● **MORGANITE LIQUID METER VALVES AND SLIDES**—Unaffected by petroleum, solvents, most acids and alkalis. Remain efficient over a wide temperature range, operate wet or dry, will not warp and are free from metallic noise. Ideal for sealed mechanisms and inaccessible locations.

FOR ENGINEERING ASSISTANCE ON YOUR SPECIFIC PROBLEMS, CONSULT—

Morganite sales engineers are available to help work out a practical solution to your design or maintenance problems.

Morganite INCORPORATED

LONG ISLAND CITY 1, NEW YORK

Manufacturers of SELF-LUBRICATING CARBON SPECIALTIES, CARBON BRUSHES AND CARBON PILES.

TRADE MARK

how to tune a sales talk to your customers' needs

Could you build volume by offering your customers newly-designed models that weigh less . . . last longer . . . look better . . . or sell for less? These are some of the user benefits that often result when manufacturers replace a heavy cast, forged or welded pipe part with a lightweight Hackney Deep Drawn Shape or Shell.

In addition, your engineers can count on Hackney Deep Drawn Parts to achieve closer tolerances . . . streamlined appearance . . . seamless construction . . . functional shapes in capacities from 1 quart to 150 gallons. Write for details—or send us a sketch of your requirements.

More than 50 years of specialized experience go into the development of Hackney Parts like these.

Hackney MILWAUKEE

Pressed Steel Tank Company

Manufacturers of Hackney Products

1442 S. 66th St., Milwaukee 14 • 1319 Vanderbilt Concourse Bldg., New York 17 • 241 Hanna Bldg., Cleveland 15 • 936 W. Peachtree St., N.W., Room 111, Atlanta 3 • 208 S. LaSalle St., Room 788, Chicago 4 • 559 Roosevelt Bldg., Los Angeles 17 • 18 W. 43rd St., Room 11, Kansas City 11, Mo.

CONTAINERS FOR GASES, LIQUIDS AND SOLIDS

New Materials and Equipment

no faulty joints, it is claimed, because the metal is automatically tinned when the paste liquifies, and the joint is made to a well tinned surface.

When heat is applied, soldering is affected wherever the paste has been painted. Any source of heat can be used—from an oxyacetylene torch to a candle, and from a soldering iron to a cigarette lighter. The low melting point of the solder is said to make it ideal for emergency repairs.

Silicone-Treated Porous Nickel Sheet

The Micro Metallic Corp., 30 Sea Cliff Ave., Glen Cove, N. Y., has announced the availability of a porous nickel sheet material, silicone treated, which is said to have the following properties: It will not pass water at less than 3 psi differential, and will pass air freely.

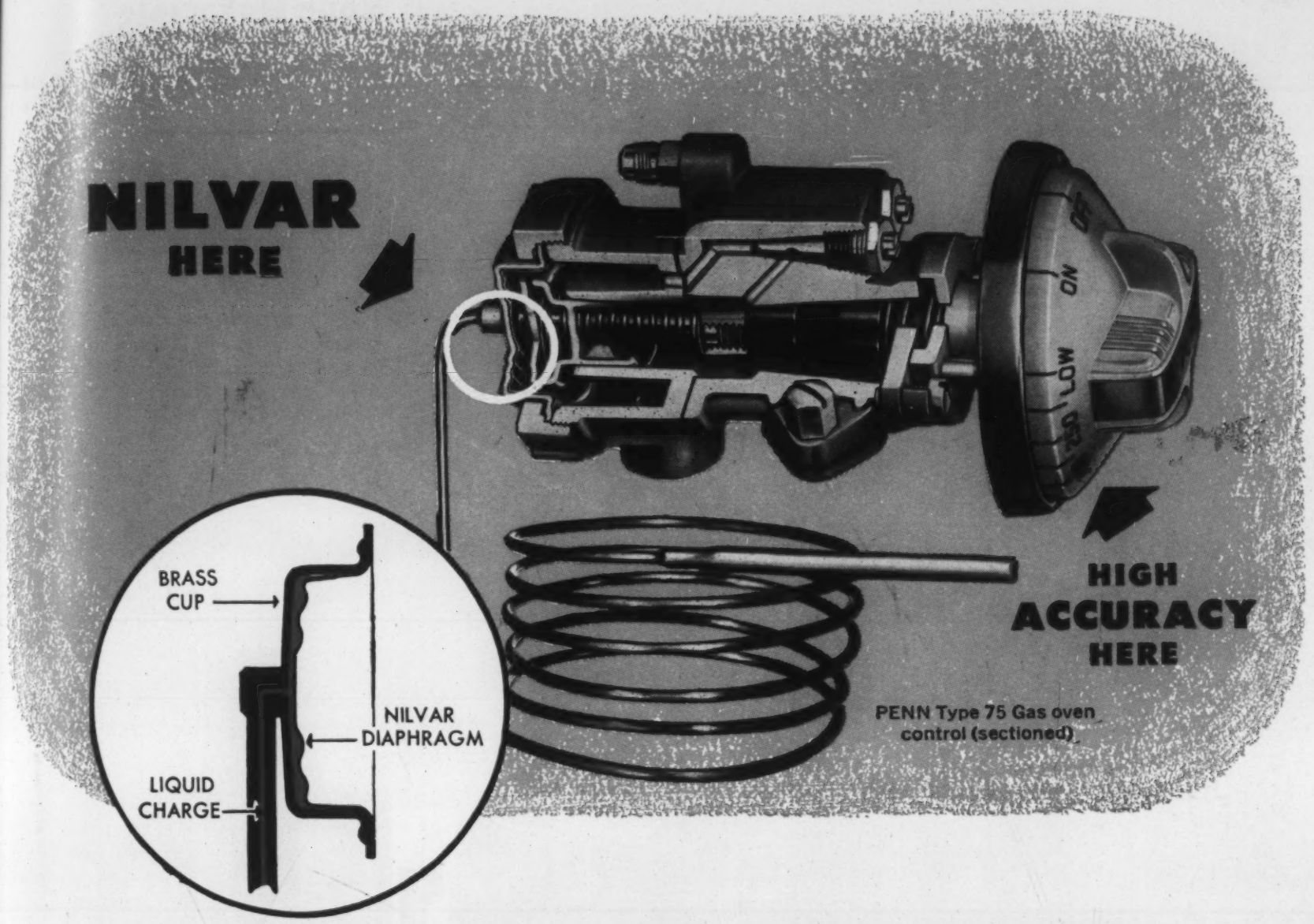
The material was developed in response to the demand for a venting medium which could be used to enclose delicate electronic equipment such as aircraft instruments. The material had to prevent water from entering these instruments under conditions of rapid changes in altitude while permitting rapid changes in pressure to be equalized between the inside and outside of the container.

Available in sheet form, the porous material can be cut to size and form required, subjected to mild forming operations, and can be welded to solid threaded components or to other fittings.

The coating is believed to be permanent under ordinary service conditions. Where mounted on the outer surfaces of aircraft traveling at high (transonic) speeds, water erosion will require occasional recoating to maintain full water repellency.

Impact Tester for Vinyl Plastic Film

A low temperature impact tester for vinyl plastic film is currently being offered to industry by the *United States Testing Co., Inc.*, 1415 Park Ave., Hoboken, N. J. The instrument is required for testing of low temperature impact in the recommended commercial standard



Nilvar* Alloy Makes New PENN Gas Oven Controls Self Compensating

By providing a self-compensating flexible diaphragm assembly for its liquid expansion controls, PENN Controls, Inc. compensates for ambient heat and eliminates control time-lag. Result: controls *accurately* maintain the temperature dialed.

The PENN Self-compensated Diaphragm assembly utilizes a brass retaining cup and a flexible Nilvar diaphragm to form a hollow chamber. This connects to the temperature bulb through a capillary tube, the entire unit being filled with a liquid charge.

Because brass expands much more than Nilvar, ambient heat *simultaneously* increases the volume of the chamber, when it increases the volume of the liquid charge. This self compensation reduces the effect of ambient heat on the diaphragm to zero and permits the diaphragm to respond *only* to bulb temperatures.

PENN specifies Nilvar for this application because it has a very low temperature coefficient of expansion —as low as .000001/C°— lowest of any alloy, and comparable to that of quartz. And its consistent uniformity helps maintain the high accuracy which PENN production standards require.

The remarkable dimensional stability of Nilvar may answer your engineering problems too. Why not talk it over with us. We'll be glad to make recommendations geared to your specific needs.

*T. M. Reg. U. S. Pat. Off.

Nilvar is produced only by

Driver-Harris Company

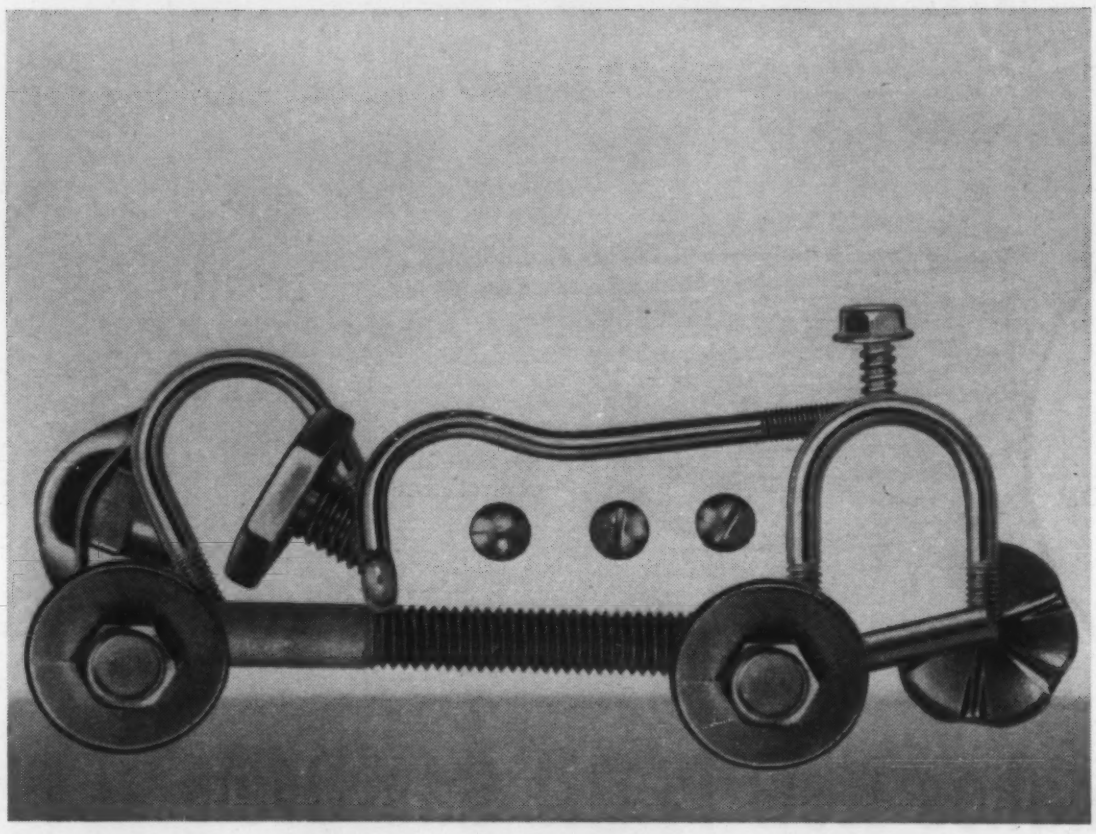
HARRISON, NEW JERSEY

BRANCHES: Chicago, Detroit, Cleveland, Los Angeles, San Francisco

In Canada: The B. GREENING WIRE COMPANY, Ltd., Hamilton, Ontario.

MAKERS OF THE MOST COMPLETE LINE OF ELECTRIC HEATING, RESISTANCE, AND ELECTRONIC ALLOYS IN THE WORLD

Designed and made for SPECIAL JOBS



● Circle ® special fasteners can give you plenty of product design and production advantages . . . simplified design, extra holding strength, easier and faster assembly, lower unit cost.

Made by modern methods to meet volume demands, Circle ® fasteners are designed to your individual requirements by specialists who can demonstrate the practical advantages of calling in Buffalo Bolt. It will cost you nothing to get the facts. Simply write us.

● To simplify specifying and ordering standard fasteners . . . write for Catalog No. 51.

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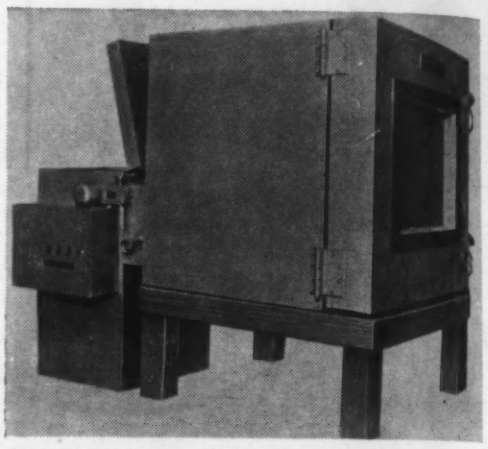
BOLT COMPANY
Division of Buffalo-Eclipse Corporation
North Tonawanda, N. Y.
Sales Offices in Principal Cities

PRODUCERS OF CIRCLE ® PRODUCTS — BOLTS • NUTS • RIVETS AND SPECIAL FASTENERS

New Materials and Equipment

for general purpose vinyl plastic film, TS-5165. Its use is also required in the standard test methods of the Plastic Coated and Film Assn.

The new tester has been designed for improved appearance and durability, and includes a mechanical release fixture to assure uniform results when used by different operators.



High and Low Temperature Environmental Test Units

Tenney Engineering, Inc., 26 Avenue B, Newark 5, N. J., has introduced a standard line of high and low-temperature environmental test equipment designed to provide test conditions for the majority of all temperature testing requirements. This standardization permits purchasers to select chambers from existing specifications and eliminates the extra cost of custom built models.

Comprising two separate units, the Tenney Servo Unit and the Companion Test Chamber, the equipment furnishes controlled temperatures for conducting physical tests, weathering tests and aging tests. The units can be purchased independently or collectively. A simple attachment is said to maintain relative humidity from ambient to 95% in a temperature range from ambient to ±180 F.

The Servo unit is a portable air conditioning unit which can be connected to laboratory enclosures to provide air circulation of 40 cu ft per min. At —100 F, this circulation will absorb 1700 Btu per hr. At temperatures to 185 F, this circulation is capable of delivering 5000 Btu heating effect. Low temperatures are achieved by circulating air over dry ice; high temperatures by circulating air around electric heaters.

The companion test chamber, an insulated chamber in which tests are actually

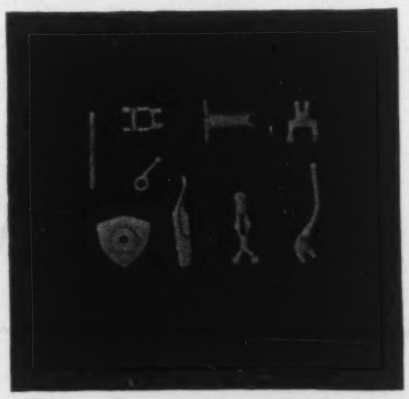
Accumet Precision Castings

for all industrial uses

With Accumet Precision Castings, Crucible has developed a process of producing precision investment castings in intricate designs with the smooth, satiny finish and closely-held dimensions characteristic of "lost wax" castings. Casting tolerances start at plus or minus 0.005" although under certain circumstances closer tolerances can be held. This relatively new metal forming process solves many difficult problems in design, tooling and production of metal components.

fuel injectors from precision castings

Fuel injectors and carburetors for aircraft are mechanisms containing a variety of peculiarly shaped component parts. The usual procedure is to use hardenable, chrome stainless steels, Types 416 and 440F, which are most adaptable to easy machining. However, to save costs in machining from bars, stocks and forgings, Crucible applied Accumet Precision Castings. The close size control and good surface finish of the castings eliminate many costly machining operations — saving manpower, machine time and tooling expense.



more information available on castings

Long a leader in the development of precision investment castings, Crucible offers you the services of an alert metallurgical staff to help you profitably apply these specialty steels to your operation. Write us for more detailed information. CRUCIBLE STEEL COMPANY OF AMERICA, General Sales and Operating Offices, Oliver Building, P. O. Box 88, Pittsburgh 30, Pennsylvania.

CRUCIBLE first name in special purpose steels

53 years of Fine steelmaking **PRECISION CASTINGS**

REX HIGH SPEED • TOOL • STAINLESS • ALLOY • MACHINERY • SPECIAL PURPOSE STEELS

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Roth (RR) Rubber Solves Rubber Problem for West Coast Manufacturer!

A simple problem for the rubber technologist, you may say. But it's significant that Tektronix, Inc.—of Portland—had Roth Rubber—in Chicago—provide the solution to this one:

Designed for television broadcasters and research laboratories, the Tektronix 524-D Oscilloscope provides the engineer with a close-up of any line or portion of the picture, enabling him to make a fine determination. This wonderful electronic instrument depends, for its viewing efficiency, on a simple, inexpensive viewing hood supplied by Roth.

The viewing hood must fit—has to adjust to any face—has to keep room light from penetrating the viewing area during observation. It must not crack or buckle.

What's YOUR rubber problem? Roth Rubber can help you, too!

• *Thirty Years in Business—Custom Manufacturers of Industrial Rubber Products since 1923*

Request Roth's Counsel—NOW!

Get Roth technical assistance without obligation. We'll be glad to help you solve your rubber problem. Write or mail coupon today.

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Send Roth Manual
Please comment on attached description of our rubber problem or production rubber requirements.

Name_____
Position_____
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City_____ Zone___ State_____

New Materials and Equipment

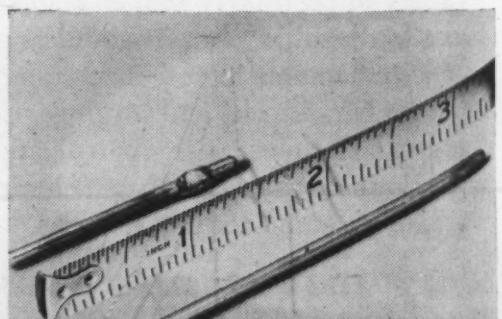
conducted, is available for use in conjunction with the Servo unit. Attachment is by means of a simple fastening device which can be disconnected to permit the Servo unit to be used as a source of conditioned air for other enclosures.

Optional equipment includes electrical connector panel, turning shafts, coaxial cable, utility ports and high-voltage.

Casting Resin for Electrical Industry

A new casting resin which is designed to permit increased application of the technique of embedding and encapsulating electronic components and circuit assemblies has been announced by *R. S. Aries & Associates,* 400 Madison Ave., New York 17.

Aritemp, as the new resin is called, is said to retain its excellent electrical properties from —76 to 390 F. It is further characterized by its superior adhesion to metals and its resistance to moisture vapor transmission. The resin is being offered as a single component system, eliminating the necessity of formulating on the part of the user prior to pouring.



Tungsten Zirconium Alloy Nonconsumable Welding Electrode

A new tungsten zirconium alloy arc welding rod that saves time and expense on inert gas welding jobs has been announced by *Sylvania Electric Products Inc.,* 1740 Broadway, New York. Called Zirtung, the new electrode is said to feature less contamination pick-up on touch start-

It is vital to maintain *Quality*

Please remember that felt is not just felt, but is an engineering material, which can and should be specified as closely as any other. It is obvious that glass-polishing felt must be different from cushioning felt, but there are finer distinctions which should be taken into account if satisfaction is to be assured.

American, the largest and oldest felt manufacturer, makes 700 different mechanical types, each having exactly-controlled characteristics. For any given application there is a specification felt that is right for the job. To select this felt and establish it as a standard is your assurance of satisfaction with your product or process.

Like other materials, felt should be bought not on price, but on the quality required for a given application. If you will do that by adhering strictly to specifications and material standards you will find felt, American Felt, will serve you supremely well in protecting the reputation of your products. Our engineers will be glad to collaborate with you on establishing the correct specifications, and our mills will adhere strictly to those specifications when your order is received.

American Felt Company

TRADE MARK

GENERAL OFFICES: 24 GLENVILLE ROAD, GLENVILLE, CONN.

SALES OFFICES: New York, Boston, Chicago, Detroit, Cleveland, Rochester, Philadelphia, St. Louis, Atlanta, Dallas, San Francisco, Los Angeles, Portland, Seattle, San Diego, Montreal.—PLANTS: Glenville, Conn.; Franklin, Mass.; Newburgh, N. Y.; Detroit, Mich.; Westerly, R. I.—ENGINEERING AND RESEARCH LABORATORIES: Glenville, Conn.

"My brushes are giving me trouble, doc—how about giving me the Stackpole treatment?"

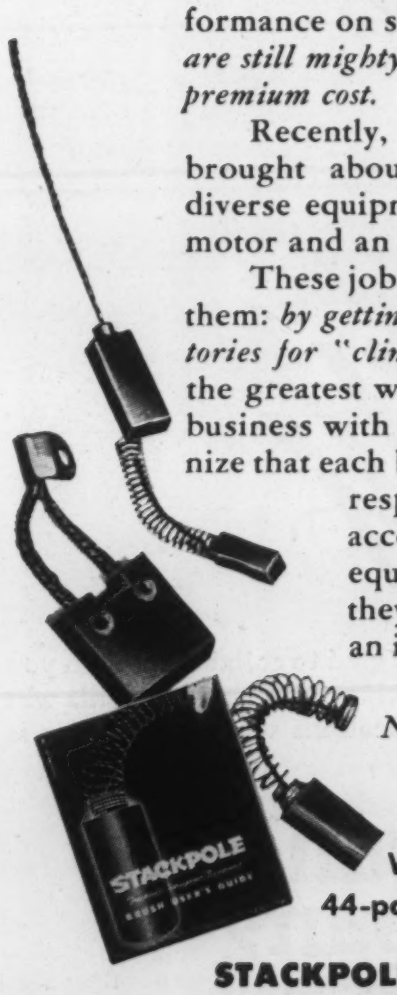
Small Motor Brush Clinic

...for longer life, greater efficiency

No doubt, you're getting pretty good brush life and performance on small motor applications these days. *But, chances are still mighty good that they can be materially improved—at no premium cost.*

Recently, for instance, Stackpole brush developments brought about worthwhile improvement on such widely diverse equipment as toy trains, a coal drill, a d-c gas pump motor and an ac-dc inverter.

These jobs were handled the way Stackpole likes to handle them: *by getting the actual motorized equipment into our laboratories for "clinical" test.* Here, Stackpole engineers combine the greatest wealth of small motor brush "know how" in the business with carefully planned experimentation. They recognize that each brush application differs from others in essential respects. These peculiarities are taken into full account in developing grades exactly suited for the equipment in question. And, more often than not, they come up with a brush recommendation that is an improvement over what has been used in the past.



NOTE: Stackpole brushes are sold only to manufacturers of original equipment.

Write on company stationery for the 44-page Stackpole BRUSH USERS' GUIDE.

STACKPOLE CARBON COMPANY, *St. Marys, Pa.*

STACKPOLE

LEADERS IN MODERN MOTOR BRUSH DEVELOPMENT

New Materials and Equipment

ing, continued steady arc and longer working life.

According to the company, the new rods are the closest commercial approach yet made to a nonconsumable electrode. Tests showed only 1 in. of Zirtung rod consumed in a 12,000-in. semi-automatic welding job on two sheets of 0.035-in. stainless steel.

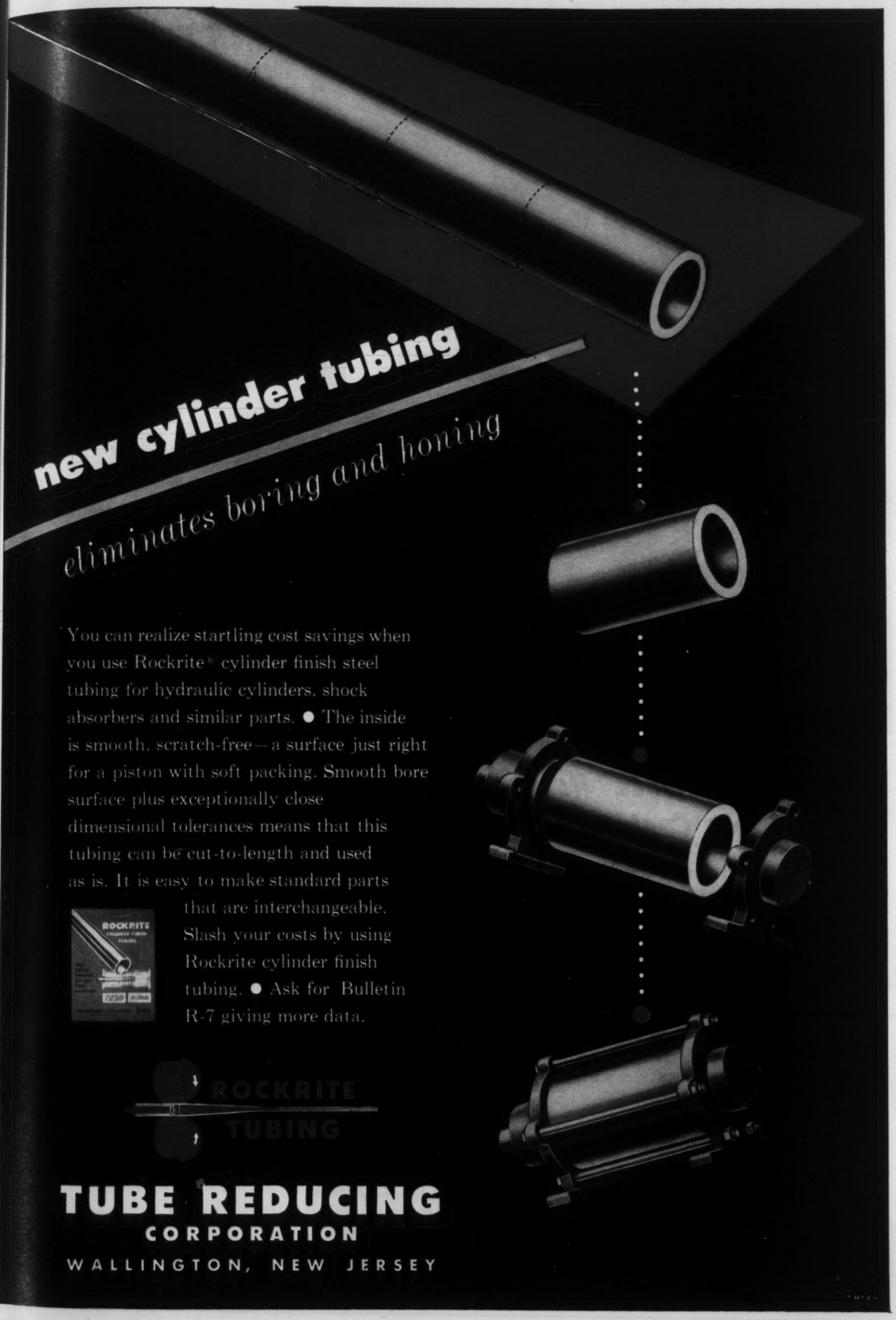
The slight contaminant pick-up and nonwavering arc of the rod is said to make it ideal for use on all metals, particularly mild steel, aluminum and magnesium where contamination on touch starting is greatest. The new electrode operates on the same current range as thoriated tungsten and contains no radioactive materials.

High Temperature Heat Treating Furnace Offered

Temperatures up to 3100 F can be obtained in a new metallurgical heat treating furnace now available from *Westinghouse Electric Corp.,* 401 Liberty Ave., Box 2278, Pittsburgh 30. A water jacketed chamber, an integral part of the unit, permits work to be cooled as well as heated in a protective atmosphere. The furnace is designed for use of either hydrogen or dissociated ammonia.

Four manually-operated, counterbalanced doors on the furnace separate its charging, heating and cooling chambers. Intended for batch-type heating, the work is handled on trays and manipulated by push and pull rods. The cooling chamber is constructed of welded steel plates to incorporate a water jacketed housing. Ample cooling surface is provided to assure cooling of the charge below the oxidation point before it is discharged.

Heating elements are formed from heavy molybdenum alloy rod into sinuous loops


new cylinder tubing
eliminates boring and honing
You can realize startling cost savings when you use Rockrite® cylinder finish steel tubing for hydraulic cylinders, shock absorbers and similar parts. ● The inside is smooth, scratch-free—a surface just right for a piston with soft packing. Smooth bore surface plus exceptionally close dimensional tolerances means that this tubing can be cut-to-length and used as is. It is easy to make standard parts that are interchangeable. Slash your costs by using Rockrite cylinder finish tubing. ● Ask for Bulletin R-7 giving more data.
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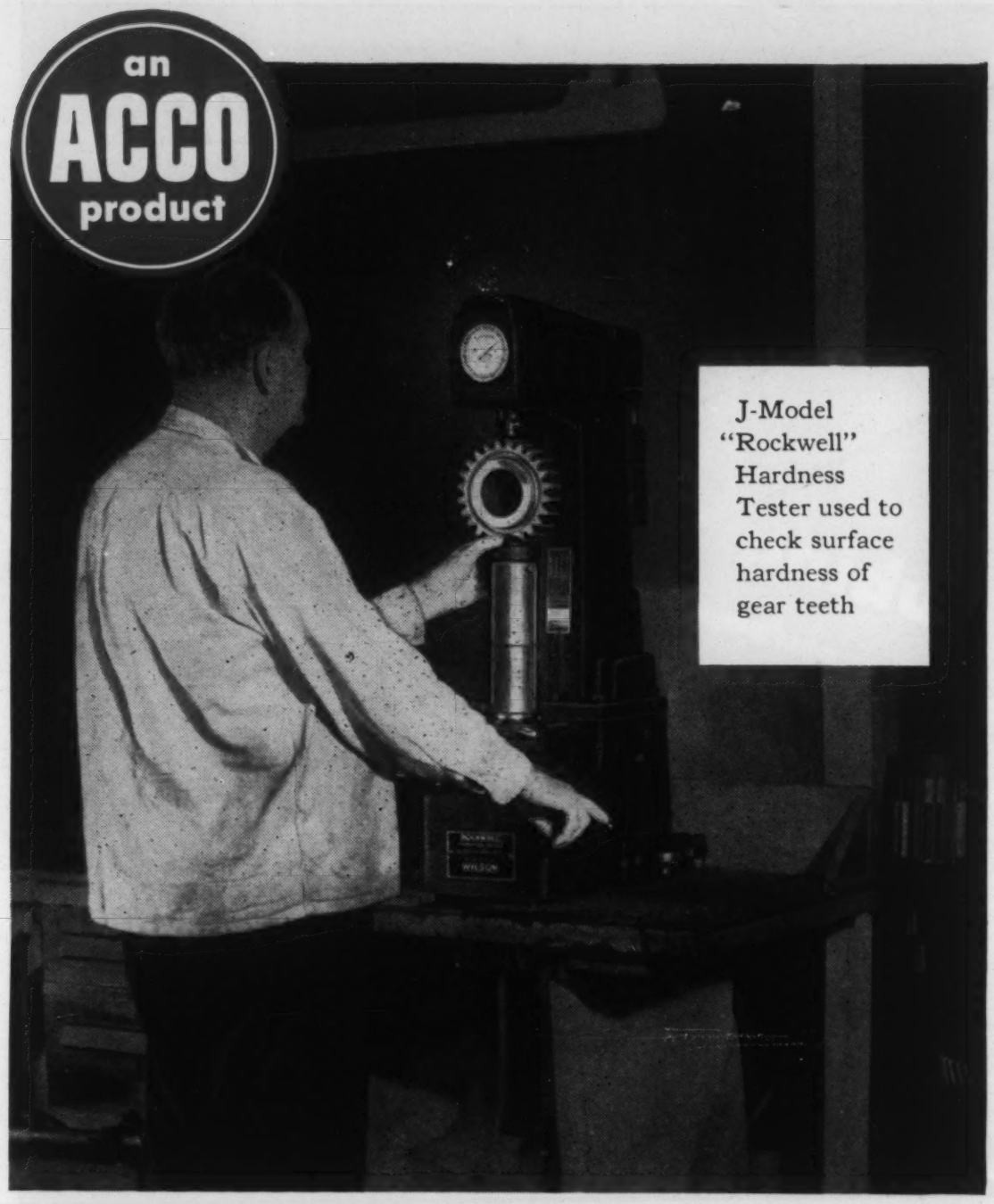

J-Model "Rockwell" Hardness Tester used to check surface hardness of gear teeth

*

How "ROCKWELL" Hardness Testers Reduce Customer Complaints

● Surface hardening of wearing parts makes them last longer but it is a job requiring skill and precision. The eye cannot detect inaccuracies but a WILSON "ROCKWELL" hardness test leaves nothing to chance.

The WILSON "ROCKWELL" Hardness Tester is a precision instrument with totally enclosed "Zerominder" dial, gripsel clamp screw for quick change and proper seating of penetrator, conveniently grouped controls, enclosed variable speed dash pot, and standardized weights.

Regular and Superficial WILSON "ROCKWELL" Hardness Testers come in many styles with accessories for testing flats, rods, rounds, odd shapes.

There is the WILSON TUKON for micro-indentation hardness testing. Write for literature.

*Trade Mark Registered

ACCO

WILSON MECHANICAL INSTRUMENT DIVISION
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230-E Park Avenue, New York 17, N. Y.

WILSON "ROCKWELL" and TUKON Hardness Testers

New Materials and Equipment

and supported on alundum refractories. The furnace hearth is made of molybdenum alloy to prevent warpage and to provide a smooth, hard surface over which the trays are easily moved.

Protective atmosphere consumption for this high temperature furnace is between 150 and 200 cu ft per hr.

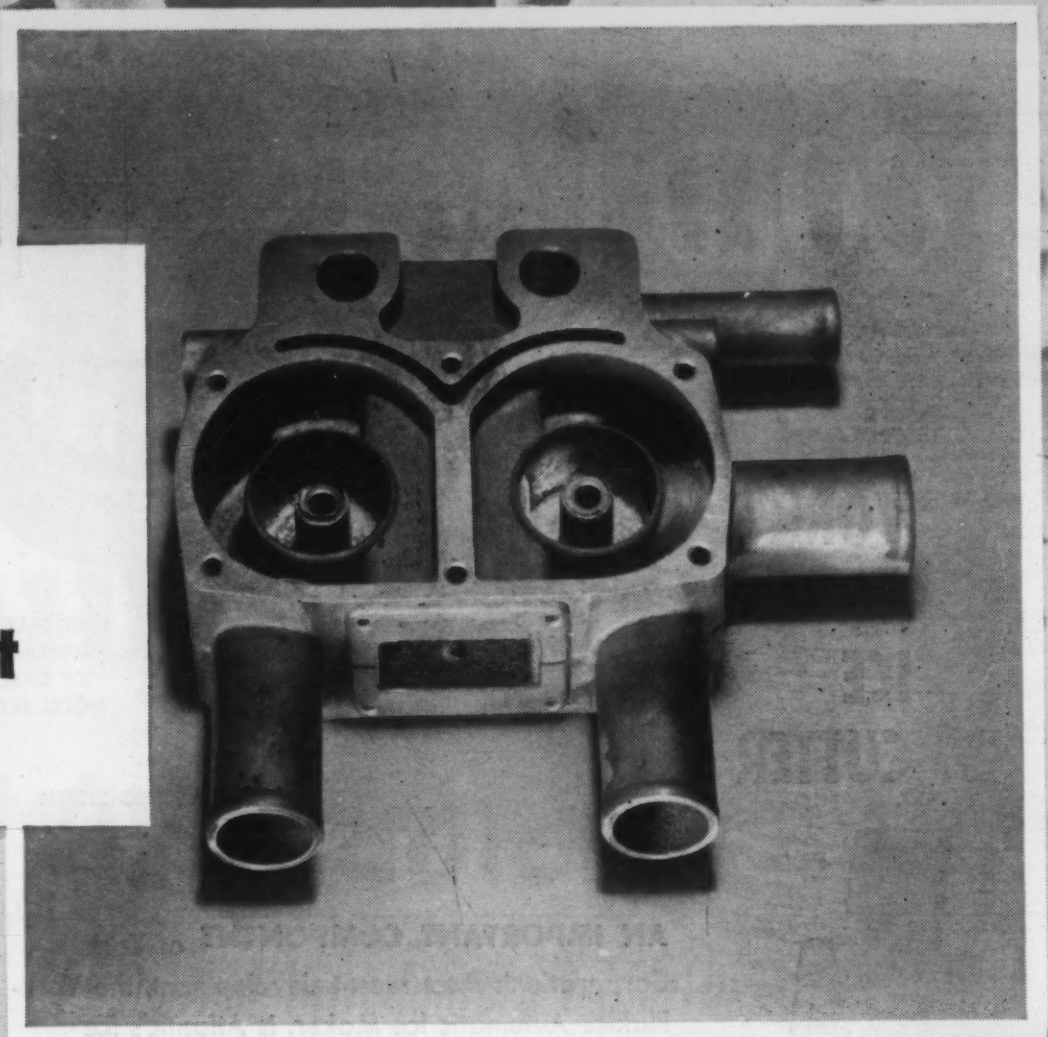
Asbestos-Neoprene Gasket Material Combines Compressibility with Heat Resistance

A new gasket material, Asbestoprene, developed from asbestos and du Pont Co.'s synthetic rubber, Neoprene, is currently being manufactured by *Victor Manufacturing and Gasket Co.*, Chicago. Unusual in that it combines compressibility with heat resistance, the new material is said to fill a gap in the company line of gasketing materials between compressed asbestos sheet and cork or rubber. Compressed asbestos sheet has excellent heat resistance, but it is quite hard and requires high sealing pressure. Cork and rubber are soft and readily compressible, but are not suitable for service involving elevated temperatures.

Formerly, when design engineers required a compromise between compressibility and heat resistance, the company and other gasket manufacturers have customarily offered glue-glycerin treated paper. Asbestoprene is a candidate for the same kind of application, but is said to be a better compromise. It is more compressible and more heat resistant than glue-glycerin treated paper—and, in addition, is claimed to have better dimensional stability. It does not cause corrosion of light metals and is resistant to oils, water, gasoline and antifreeze solutions.

Automotive applications are a natural prospect for the new material. It is reported to have been highly successful, for example, as the valve cover gasket on tractor engines. This gasket is exposed to heat from the engine and manifold, and design of the valve cover is such that only a light bolting pressure can be applied to the gasket. Physical properties of the material are listed below:

Tens. Str.:	1500 psi min. in machine direction, 500 psi min. in the cross-machine direction
Mullen Burst Str.:	130 lb per 1/16-in. gage



PRODUCT:
De-icer pump casting
MATERIAL:
Aluminum alloy
EQUIPMENT:
140 kv x-ray machine

What's the right X-ray film?

KODAK INDUSTRIAL X-RAY FILM, TYPE A

IN ADDITION to the vital importance of this unit to the safety of aircraft and airmen, close machining was called for. So to be sure that no porosity existed to cause weakness or waste valuable machining time, all castings were radiographed.

For these radiographs, the radiographer used 90 kv, 60-sec. exposure at 40-in. tube distance—no lead screens—and Kodak Industrial X-ray Film, Type A.

This film is the first choice for examination of light alloys using short exposures at low voltages. It also has high contrast with fine graininess and speed enough to take full advantage of high kilovoltage equipment in radiographing thick or dense materials.

A RIGHT FILM FOR EVERY PROBLEM

Whatever your radiographic problem, you'll find the best means of solving it in one of Kodak's four types of industrial x-ray film. This choice provides the means to check castings and welds efficiently, offers optimum results with varying alloys, thicknesses and radiographic sources.

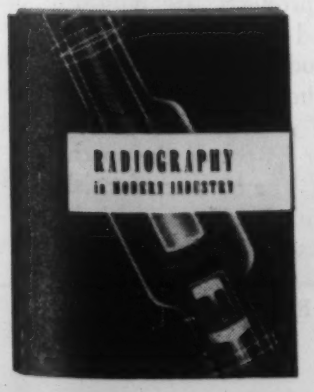
Type A—has high contrast and fine graininess with adequate speed for study of light alloys at low voltage and for examining heavy parts at intermediate and high voltages. Used direct or with lead-foil screens.

Type M—provides maximum radiographic sensitivity, with direct exposure or lead-foil screens. It has extra-fine grain and, though speed is less than Type A, it is adequate for light alloys at average kilovoltages and for much million- and multi-million-volt work.

Type F—provides the highest available speed and contrast when exposed with calcium tungstate intensifying screens. Has wide latitude with either x-rays or gamma rays when exposed directly or with lead screens.

Type K—has medium contrast with high speed. Designed for gamma ray and x-ray work where highest possible speed is needed at available kilovoltage, without use of calcium tungstate screens.

Radiography . . . another important function of photography



RADIOGRAPHY IN MODERN INDUSTRY

A wealth of invaluable data on radiographic principles, practice, and technics. Profusely illustrated with photographs, colorful drawings, diagrams, and charts. Get a copy from your local x-ray dealer—price, $3.

EASTMAN KODAK COMPANY
X-ray Division • Rochester 4, N. Y.

Kodak
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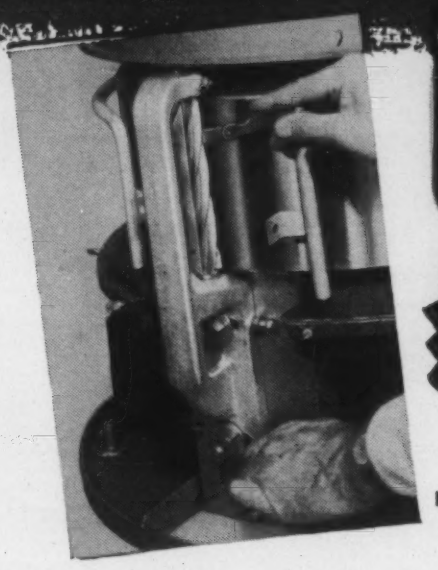
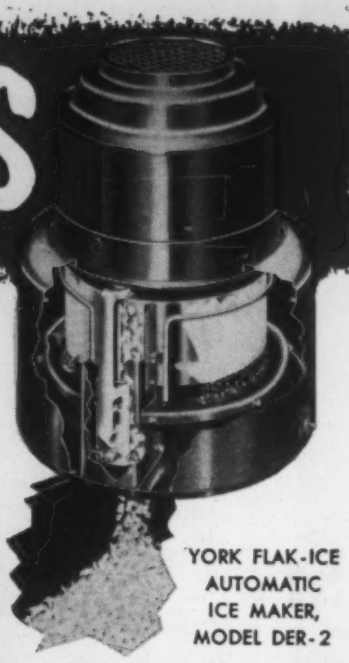
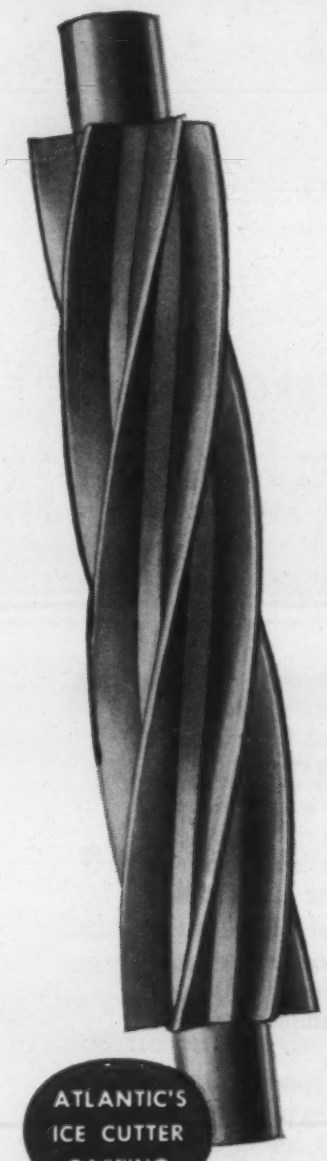
COLD FACTS about YORK'S new ICE CUTTER



ICE HARVESTING SYSTEM



YORK FLAK-ICE AUTOMATIC ICE MAKER, MODEL DER-2



ATLANTIC'S ICE CUTTER CASTING

AN IMPORTANT COMPONENT of York Corporation's most recent development, the York-Flakice Automatic Ice Maker, is Atlantic's ice cutter casting. It cuts the ice into curved flakes... so delicate they will not damage or puncture delicate rose petals.

YORK'S ORIGINAL CONCEPTION of the ice cutter... a vital part of the ice harvesting system ...consisted of three stainless steel parts which had not only to be machined, but welded together.

ATLANTIC'S ENGINEERS suggested a design that eliminated these costly operations and increased the productive efficiency of the ice cutter. Six spiral blades on a center shaft were all plaster mold cast in one piece of Atlantalloy #31 High Tensile Manganese Bronze... an alloy of great endurance and strength.

York will testify that Atlantic's all-in-one-piece ice cutter casting surpassed all requirements for high physical values, closely-held tolerances, satin-smooth finish, fine-grained structure, clean-cut surfaces... and afforded them substantial savings over former costs.

Find out how the Atlantalloy plaster mold casting process can help solve some of your problems' Write for a free copy of "High Quality Precision Castings for Industry" today!

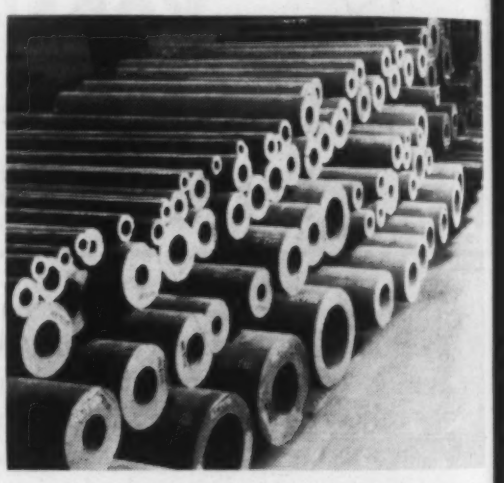
ATLANTIC CASTING and ENGINEERING CORP.

Established 1937

721 Bloomfield Avenue • Clifton, N. J. • PRescott 9-2450

New Materials and Equipment

Compressibility:	20 to 30% at a loading of 1000 psi
Recovery:	40% min.
Hardness:	70±10 Shore Durometer A
Flexibility:	A 1/16-in. sheet can be bent around a 1/32-in. mandrel without cracking
Oil Res.:	90% min. retention of tensile strength, and 5% max. thickness change, after 5-hr immersion at 300 F in ASTM No. 1 test oil
Gasoline Res.:	0 to ±5% thickness change after 5-hr immersion at 70 F in ASTM No. 1 reference fuel



New Types of Hollow Tool Steel Bars Now Available

Availability of new type hollow bars of tool steel to supplement the solid bars, forgings, wire and drill rod that now comprise the company's tool steel line has been announced by *Crucible Steel Co. of America,* 405 Lexington Ave., New York 17. Distribution of the new product will be handled through the company's nationwide warehouse and mill system.

The new steel bars are designed to speed the fabrication of ring shaped parts which traditionally have been cut out of solid bars or special forgings. Manufacturers of can dies, trim dies, liners, ring gages and similar products, are typical of those firms expected to comprise the market for the new product. It is the company's belief that such parts can be made from hollow bars more economically because the fabricator by-passes the machining of central areas. The bars are furnished with a prior-machined surface and hole.

Three types of Crucible's tool steels are

Corrosion Resistant Zirconium Metal Now available

(limited introductory quantities)

The extraordinary resistance of Zirconium Metal to nearly all forms of chemical attack offers many practical and advantageous applications. It compares with tantalum in acid resistance and surpasses tantalum in resistance to alkalies.

Present and promising applications are in the field of electronics, chemistry, aviation and surgical use among others.

Now offered in limited commercial quantities, Zirconium Metal can be machined, welded and cast. Write for literature giving physical, mechanical and chemical properties as well as supply and prices.

BARS

RODS

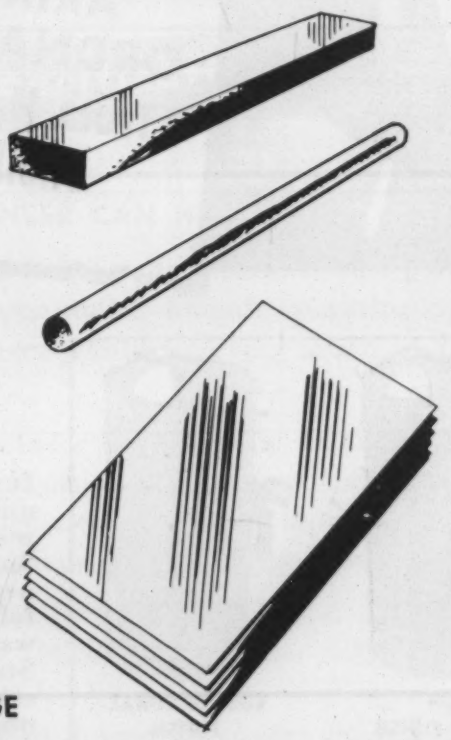
SHEET

WIRE

SPONGE

BRIQUETTES

TUBING



Zirconium Metals Corporation of America

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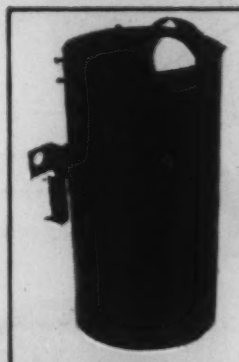
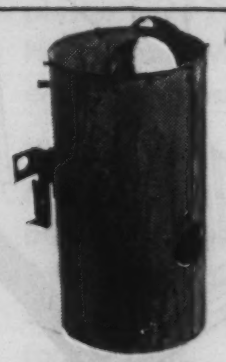
Withstands 500° F. in Color Application

SICON Olive Drab Adopted by STEWART-WARNER for ARMY ORDNANCE Truck Heater Shells



SICON SILICONE FINISH



CONVENTIONAL FINISH

These two heater shells were subjected by Midland Engineers to a 500°F. heat test, for four hours, followed by a 300 hour salt spray test conforming to ASTM B117-49T. SICON retained color, gloss, adhesion. A widely used specification finish for this purpose failed completely. The pictures tell the story.

ACTUAL TESTS PROVE SICON'S SUPERIORITY

It was felt that army ordnance requirements for truck heaters demanded an olive drab protective finish that would withstand temperatures of approximately 500° F., followed by a salt spray test. SICON was tried and is being used by Stewart-Warner in production because it met these rigorous demands.

If you require a finish in a *decorative color* with specific heat resistant properties, SICON, the original Silicone-Base Heat Resistant Finish, may be the *only* finish that will do the job. It will pay you to investigate. Write for illustrated brochure without obligation.

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New Materials and Equipment

available in hollow form. These are an air hardening type known as Airdi 150, an oil hardening type called Ketos, and Sanderson, a water hardening steel.

Warehouse stocks of the hollow tool steels range from 2-in. round with a 1-in. hole to 16-in. round with a 12-in. hole.

Noncorrosive Rosin Core Solder

A new rosin core solder, active yet noncorrosive, has recently been developed by *Federated Metals Div., American Smelting and Refining Co.*, 120 Broadway, New York. Known as RTS 200, the solder has been proved in production operations to have many advantages over ordinary rosin solders.

Tests show that the spread of the new solder is 30% greater than that of conventional rosin core solders. Oxide films and corrosion products on the parts being soldered need not slow down operations, because the new product is said to pierce such retarding agents four times faster than ordinary solders.

Despite the exceptional activity of the RTS 200 flux at soldering temperature, there is no harmful corrosion residue when tested under the high humidity conditions of military specification MIL-S-6872. Experience has shown that the flux in the new solder is just as active after standing for long periods as when used immediately.

Aluminum-Oxide Compositions for Zinc-Base and Aluminum Die Castings

The Hanson-Van Winkle-Munning Co., Matawan, N. J., has announced a new series of aluminum-oxide compositions for the coloring operation in the finishing of zinc-base and aluminum die castings. Laboratory tests and supporting field data indicate that these aluminum oxide compositions give castings of these metals the desired luster or color faster than was possible before with compositions of the same grade of fineness.

The aluminum-oxide compositions can also be used in steel and stainless steel finishing, according to the company.

If you need

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to meet exacting tolerance specifications for really rough resistance requirements

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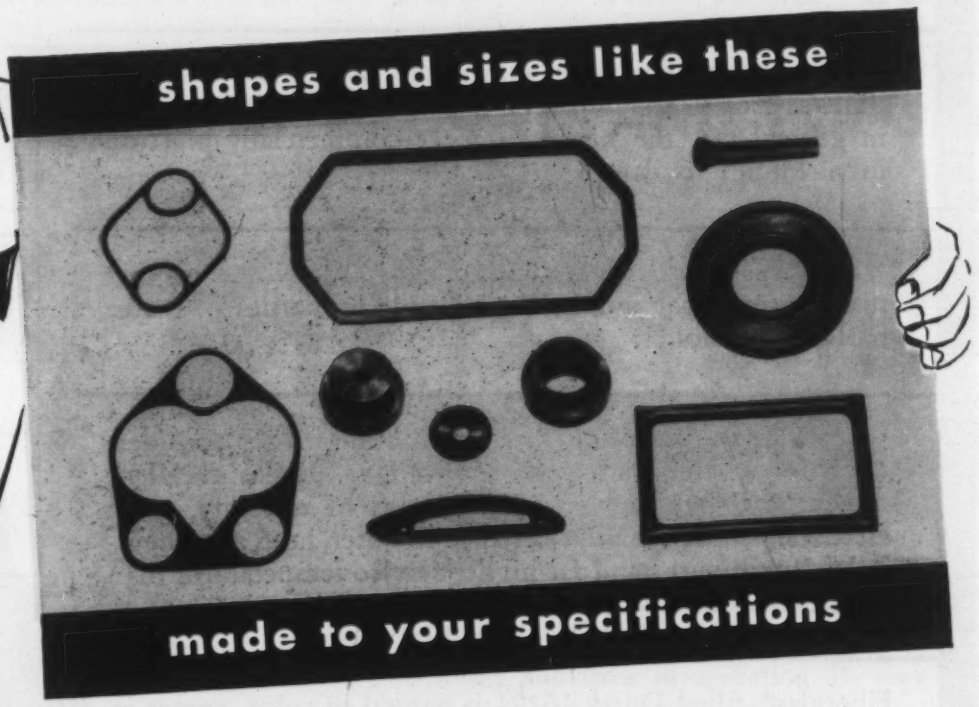
. . . for service with special fuels or lubricants
. . . for service with acids or gases



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PARKER—leading manufacturer of synthetic rubber O-rings—has had years of experience in precision molding special-purpose rubber parts for the automotive, electrical appliance and other industries. PARKER Laboratory Technicians have developed hundreds of special compounds to meet special requirements.

EXCLUSIVE NEW TECHNIQUES—Now, with newly perfected, low-cost, high-production processes and molding methods, PARKER offers even greater values in superior custom molded rubber parts. Why not investigate this PARKER service! Mail the coupon TODAY.

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...highest ever in high-impact phenolic!

Durez now offers you a phenolic plastic molding material having an impact or shock strength in foot-pounds per inch (Izod) ranging up to 30.

This compares favorably with some metals. It is several times as great as the impact strength of molding compounds in general use, the highest impact commercially practical in phenolics to date.

Fiberglas*, the strengthening agent, is used in a manner that conserves the industrially valuable properties of Durez molding phenolics.

Known as Durez 16221, the new material invites consideration for a large variety of applications. It has excellent dimensional stability, a high modulus of elasticity, good electrical properties and resistance to water, heat, and chemicals. It will withstand far higher service temperatures than cellulose-filled materials.

Fiberglas*-filled Durez 16221 is natural in color, comes in dry form, and is readily molded by standard compression methods. It produces parts or components having dependably uniform characteristics.

As specialists in phenolics for 32 years, we offer you the counsel of our field technical staff in investigating the profitable application of Durez 16221, which is now in commercial use.

*Owens-Corning Fiberglas

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PHENOLIC RESINS
MOLDING COMPOUNDS
INDUSTRIAL RESINS
PROTECTIVE COATING RESINS

PHENOLIC PLASTICS THAT FIT THE JOB

News Digest

Materials Supply . . .

continued from page 7

agreements with Olin Industries, Inc., for 110,000 tons, and The Harvey Machine Co., Inc., for 54,000 tons, the Wheland installation will boost the nation's aluminum capacity to 1,746,000 tons, expected to be available by 1955.

In 1950, domestic capacity was 719,000 tons. The first and second rounds of post-Korea expansion brought the capacity goal to 1,546,000 tons by 1955. The new goal represents an increase of 140% over the 1950 level.

As a result of the post-Korea expansion, the "big three" of the industry, Aluminum Co. of America, Reynolds Metals Co. and Kaiser Aluminum Co., have been joined by four new entries. In addition to those mentioned above is Anaconda Copper Mining Co.

With imports from Canada and from other sources, it is estimated that the total annual aluminum supply available to the U. S. will reach approximately 2,390,000 tons by 1955, compared to 1,206,700 tons in 1950, an increase of almost 100%.

Rubber Use Up . . .

The nation's new rubber consumption rose to a record-breaking 1,261,317 long tons last year. This was almost 3000 tons above the previous high of 1,258,557 long tons in 1950.

However, total 1952 rubber consumption of 1,401,316 long tons was somewhat below the 1950 figure because of a drop-off in the use of reclaimed rubber. According to the National Production Authority, reclaimed rubber inventories are the lowest since July 1950, but there is enough capacity to supply a much higher demand if needed.

Tin Consumption Off . . .

Tin consumption in the U. S. dropped last year to 45,500 tons, compared to 56,884 tons in 1951.

Domestic production of tin metal showed a corresponding drop from 30,921 to 22,541 tons.

These figures were contained in a report issued recently by the International Tin Study Group, The Hague, the Netherlands, and are based partly upon estimates.

The lower domestic consumption was in harmony with the world pic-

ORTMAN-MILLER SAYS . . .

WARPAGE AND BENDING ELIMINATED

MACHINING SPEED INCREASED 20%

WITH GROUND AND POLISHED

STRESSPROOF®

SEVERELY COLD-WORKED, FURNACE-TREATED STEEL BARS

This piston rod, made by Ortman-Miller Machine Co., Hammond, Ind., for their hydraulic cylinders, is machined from Ground and Polished STRESSPROOF.

When this piston rod was made from C1018, Ortman-Miller had trouble with warpage after machining, and with bending and wear in operation. By switching to Ground and Polished STRESSPROOF, warpage was eliminated and machining speed increased 20%. In addition, STRESSPROOF had the strength to prevent bending, and wear became no problem.

STRESSPROOF has improved quality and lowered costs in hundreds of similar applications because of its unique combination of four qualities in-the-bar: (1) *High Strength*, double that of ordinary cold-finished shafting; (2) *Machinability*, fully 50% better than heat-treated alloys of the same strength; (3) *Wearability*, without case hardening; and (4) *Minimum Warpage*. STRESSPROOF is available in cold-drawn or ground and polished finish.

STRESSPROOF makes a better part at lower cost.

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News Digest

ture, which saw total consumption slip from 137,000 to 128,000 tons. But world metal production held steady at about 167,500 tons, and world ore production jumped from 167,500 to 172,500 tons.

Heavy Castings Expand . . .

A program designed to add 160,000 tons of gray iron castings weighing over 3000 lb to the annual capacity by July, 1954 has been announced by the Office of Defense Mobilization.

The new goal provides that such expansion may be achieved either through completely new facilities capable of producing castings weighing over 3000 lb, or through additions or modifications of existing facilities not presently able to produce castings of this size.

In mapping this most recent expansion program, government officials took note of the fact that crane and cupola capacities in most gray iron foundries are not sufficient to handle the larger castings needed for many machine tool bases which may run up to 25 tons or more.

Copper Recovery . . .

More efficient recovery of copper from mine waste is foreseen by Prof. C. C. DeWitt, director of Michigan State College's Engineering Experiment Station, as a result of a newly developed flotation process for copper silicate.

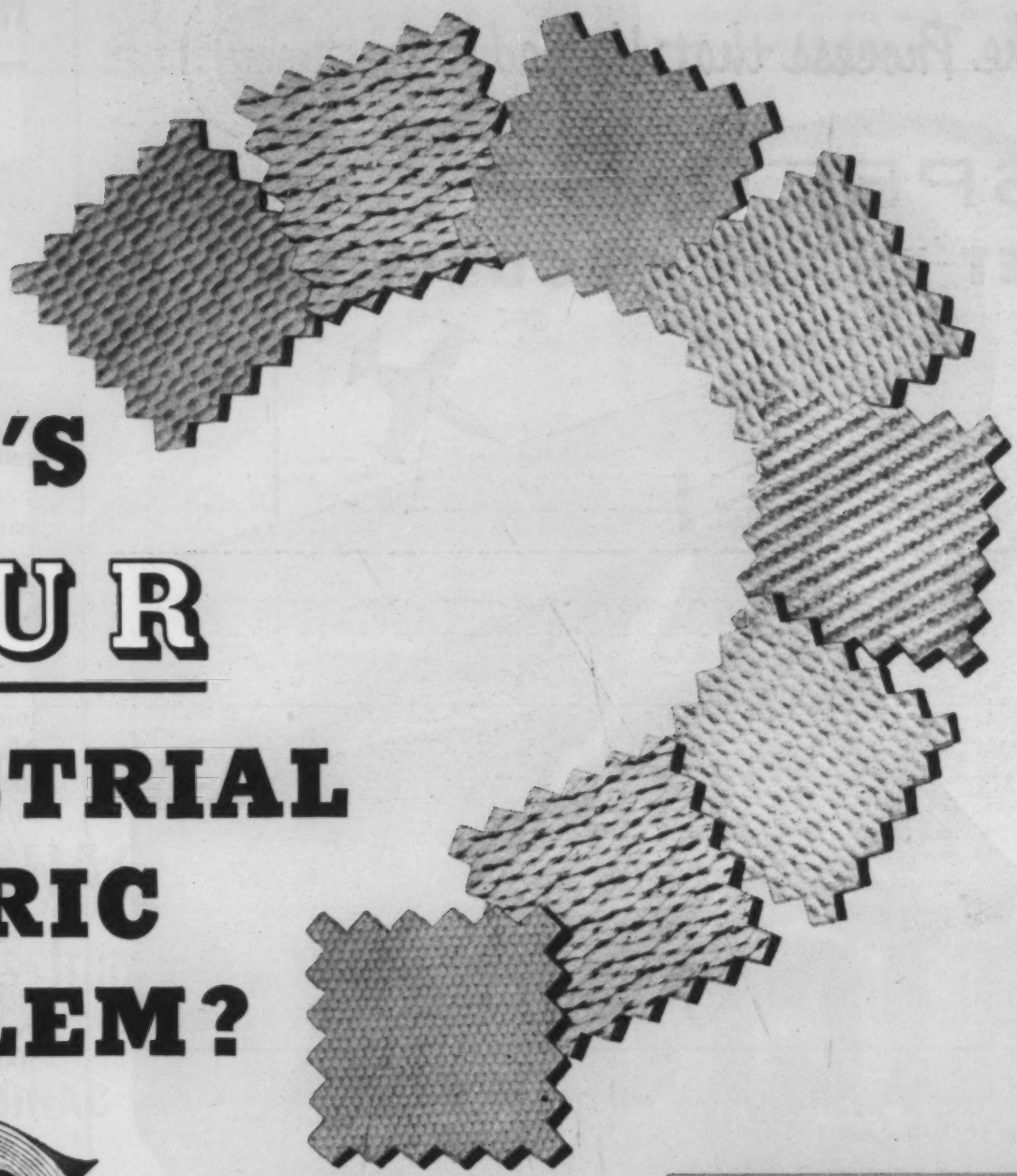
In view of the continuing demand for copper and the lifting of price controls on this metal, it is possible that the new flotation process may spur a more ambitious waste recovery program with resultant advantages to the national economy.

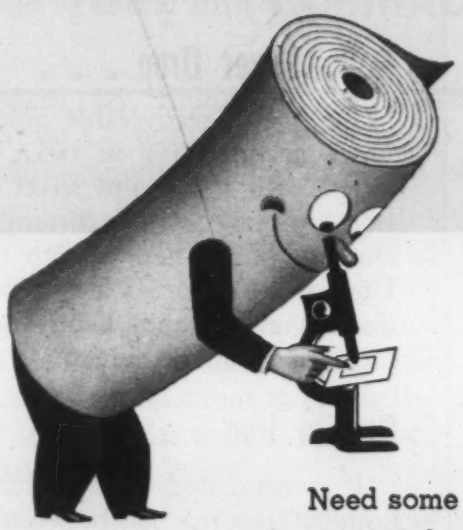
According to Prof. DeWitt, vast waste dumps containing copper silicate have accumulated for the past 40 years at most copper mills where sulfide has been extracted from the ore.

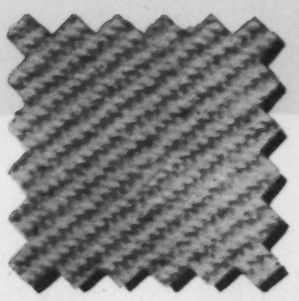
At one mine alone, he says, a waste dump contains "several hundred million dollars worth" of copper "ready for an economic separation method." The waste dump contains 0.2 to 0.3% copper as low-grade copper-bearing mineral.

Although commercial chemical processes are being used to recover copper from the waste dumps by acid treatment, Prof. DeWitt believes that

WHAT'S YOUR INDUSTRIAL FABRIC PROBLEM?







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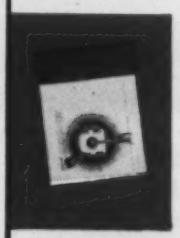

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News Digest

much higher yields could be obtained by first separating the copper silicate and then treating it with acid.

The flotation process for copper silicate developed in the MSC laboratories makes use of a new synthetic coal-tar product. In some experiments, only 1 lb of this chemical was needed to recover 17 lb of copper in the silicate form.

Another recent development apparently aimed at getting more copper on the market is the opening of a tin-can-shredding plant in Houston. The shredded scrap iron is to be used in Arizona, Utah and Montana for precipitating "cement" copper from mine waters. It is estimated by the National Production Authority that such copper will average about 10% of the domestic production.

World's Steel . . .

It is estimated that the world's production of steel fell about 0.4% in 1952 from the previous year. However, the estimated total of over 229,500,000 net tons was second highest in history, exceeded only by 1951.

Gold, Silver Drop . . .

Output of recoverable gold by the U. S. declined 5% in 1952, as compared with 1951, and silver production dropped 2%, according to the Bureau of Mines. South Dakota, Utah and California led in gold production and Idaho, Utah and Montana led in silver output.

Ductile Iron . . .

It is estimated that production of nodular iron reached between 80,000 and 100,000 melt tons in 1952, an increase of 50 to 100% over 1951.

Glass Tubing . . .

Production capacity interim gold for lead and soda-lime glass tubing, rods and cane has been pushed up to 264 million lb by 1956, an increase of 17% over 1952 capacity, by the Defense Production Administration.

A new goal was also set for borosilicate glass tubing, rods and cane: 44 million lb by 1956, an increase of 63% over 1952 capacity.

Lead and soda-lime glass tubing is used in most electronic devices required for fire control, radar,

(*Continued on page 182*)

Dipped rotors are rotated in curing oven at 300° F for 1 to 2 hours to assure even distribution of the resin and prevent wasteful drain-off of resin.

generator rotors before ation with LAMINAC 4128.

After impregnati tough, sta lating formed.

LAMINAC® Resin cuts impregnation time of generator parts from 70 to 4½ hours—reduces rejects 15%!

rotors impregnated with LAMINAC withstand terrific centrifugal force and heat of 6,000 rpm speeds!

Needed: By Eclipse-Pioneer Division of Bendix Aviation Corporation, an impregnating material for aircraft generator windings that would stand up under the toughest operating conditions. Former materials would gas or soften at high operating temperatures.

Chosen: LAMINAC polyester resin 4128, for its excellent electrical properties, high heat resistance, high rigidity—for its superior protection against moisture and fumes. LAMINAC 4128 worked better than any other material tried.

Specifications: *Parts:* rotors that reach speeds of 6,000 rpm at high altitudes, stators, other electrical windings. *Insulation:* each strand of cotton-wrapped wire is completely insulated against moisture and arcing. *Strength:* each strand firmly anchored despite the strains generated by high speed.

Success: Impregnation time cut from three days to 4½ hours—only one dip required, solvent loss and post-cleaning completely eliminated, rejects cut 15%! Performance matches production efficiency, too. Tests have proved that LAMINAC impregnated parts operate efficiently at high voltages and temperatures without significant variations in electrical characteristics. Here are economies and efficiency applicable to many types of electrical equipment!

✓ **REMEMBER . . .** only in the large family of LAMINAC polyester resins will you find the combination of service qualities you need in superior degree. We will be glad to help you determine the right LAMINAC for your requirements in electrical and other applications.

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On any steel blackening problem

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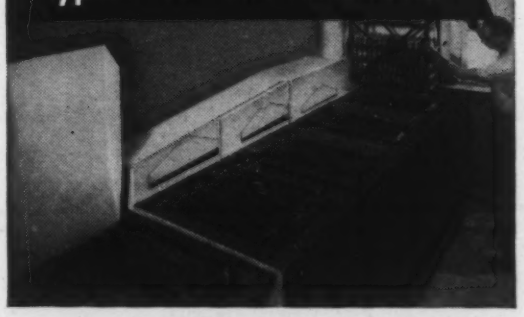
Courtesy The Poly Choke Co.

Du-Lite gave this part with its complicated knurls, slots, threads, etc. a fine rust-resistant durable black finish. It is typical of many other parts, small and large, which have been black oxidized by Du-Lite for many years. Moreover, Du-Lite meets most individual and government specifications including 57-0-2C for Type III Black Oxide finish.

Typical Du-Lite installation



Du-Lite installations are simple, compact, easy to operate. Du-Lite equipment can be tailored to fit production requirements on all types of jobs with a maximum of speed and economy. Du-Lite also makes a complete line of cleaners, strippers, wetting agents, passivating agents, rust preventatives, burnishing compounds etc. for any metal finishing application.

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Pads of bonded glass fibers cushion shock of heavy machinery.

New Glass Fiber Mat Has Controlled Resiliency

by **KENNETH ROSE**, Mid-Western Editor, Materials & Methods

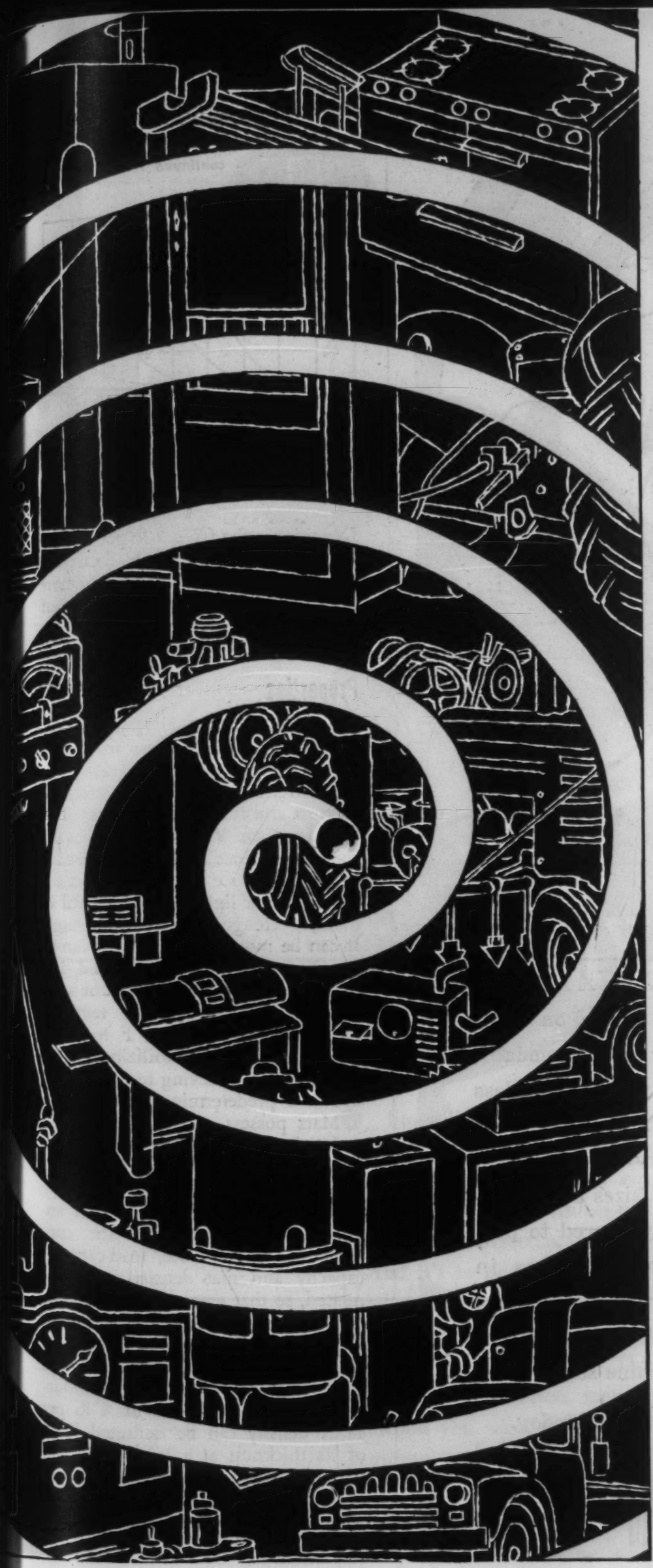
Possesses all the general properties of glass fiber mats. It will find use in many damping and cushioning applitions.

● Mats made of unoriented glass fibers bonded with a small amount of a synthetic resin binder have been widely used as a thermal insulator, as a filter medium for gases, and as a sound deadener. It has also found some use as a cushioning material against shock or vibration. In all of these uses the special properties of the glass fibers will justify its higher cost for many applications.

A special type of glass mat, in which the density and resiliency of the mass of fibers is closely controlled, has recently been announced as available for civilian use. This material, originally prepared for use in an ordnance item, is offered under the trade name Vibraglass, and is made by the Vibraglass Div., Vibradamp Corp., a subsidiary of Glass Fibers, Inc. Although it has all of the general properties of glass fiber mats, the special properties of the material have directed most of its output to the field of vibration damping.

The mat is made of glass fibers of small diameter—about 0.00013 in.—processed so that each fiber is coated with a phenolic resin to protect against abrasion of one fiber over another. The mass is compressed and cured to a batt of a given density.

(*Continued on page 178*)



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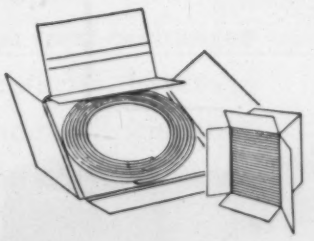

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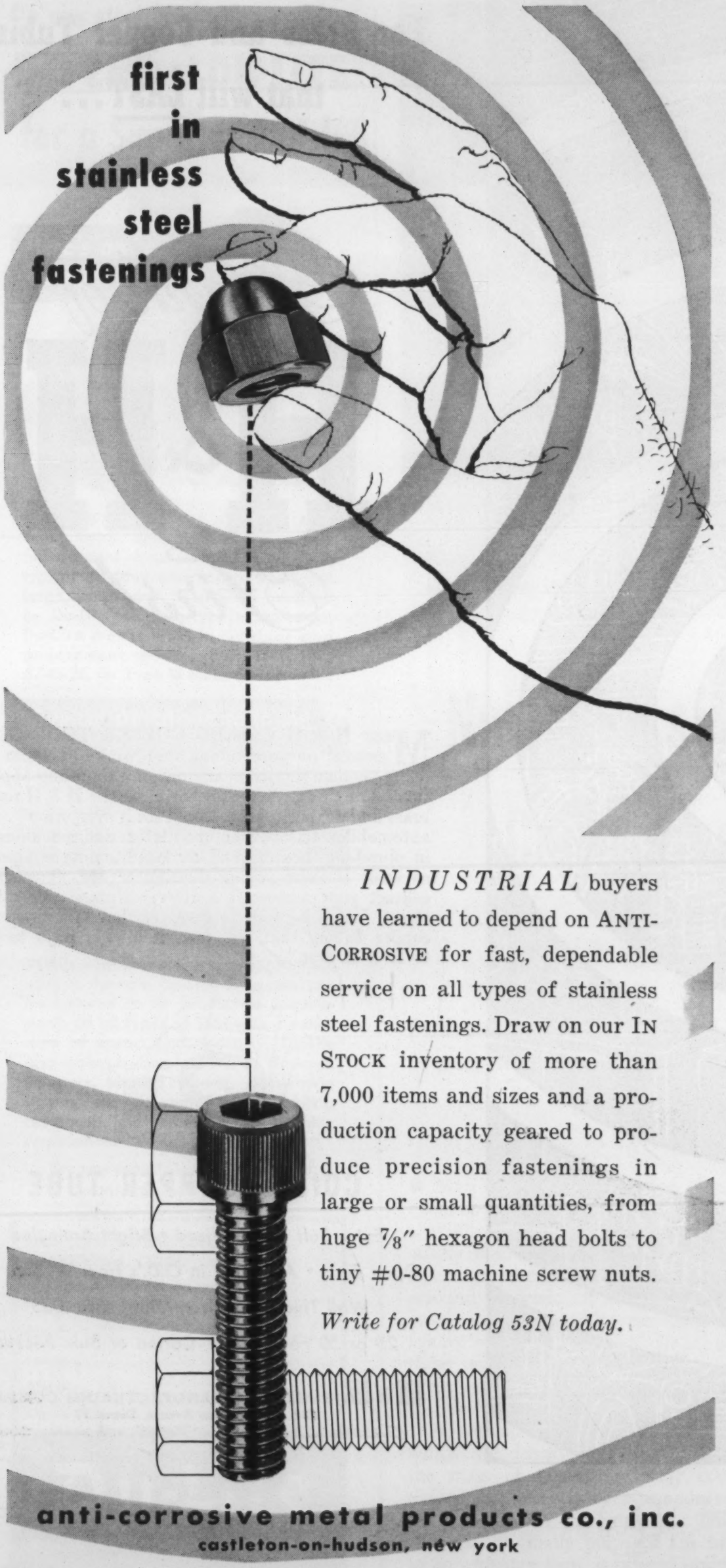
Open Ends • Available in O.D.'s from ⅛" thru ⅝"

Wall Thicknesses from .030" thru .035"

25 or 50 Foot Coils • Carton or Bulk Packed

H&H TUBE AND MANUFACTURING COMPANY
252 North Forman Avenue, Detroit 17
Originators and sole makers of "Metalflo"—the economy tubing

METALFLO LOCKSEAM COIL STRIP AND SEAMLESS TUBING TUBULAR PARTS



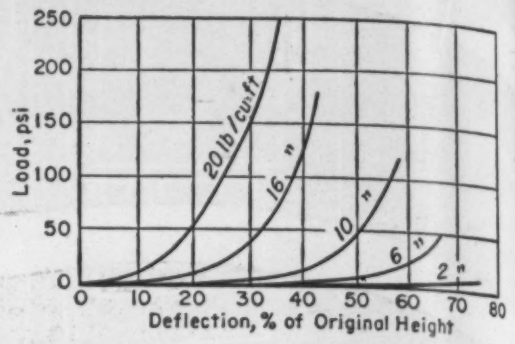
INDUSTRIAL buyers have learned to depend on ANTI-CORROSIVE for fast, dependable service on all types of stainless steel fastenings. Draw on our IN STOCK inventory of more than 7,000 items and sizes and a production capacity geared to produce precision fastenings in large or small quantities, from huge 7/8" hexagon head bolts to tiny #0-80 machine screw nuts.

Write for Catalog 53N today.

anti-corrosive metal products co., inc.
castleton-on-hudson, new york

New Glass Fiber Mat . . .

continued from page 176



Load-deflection curves showing range of load carrying properties of standard density Vibraglass materials.

Densities range from 2 lb per cu ft to 60 lb per cu ft, and load-carrying capacity can be less than 1 psi to more than 2000 psi. The percentage of phenolic resin used as a binder can vary from 5% to about 50%.

Properties

In addition to such properties as resistance to deterioration at elevated temperatures, chemical resistance, high strength, reistance to attack by bacteria and fungi, and high moisture resistance, the Vibraglass mat has excellent resilience, low permament set, and long service life under vibrating load. It is a lightweight material in that the strength-weight ratio is high. It can be molded to shape, or can be punched, drilled, sawed, turned, and otherwise fabricated in much the same manner as wood. Service temperatures range from –100 F to about 375 F. A patented stabilizing process permits stress-relieving to give longer life at a predetermined load.

Mats possess good resiliency, and make the recovery after compression very quickly. The return to original dimensions may be said to take place immediately, as far as practical engineering considerations are concerned. The resilience, load-carrying capacity and mat density are interrelated, so that greatest deflection can be obtained in the lighter densities, while greatest load-carrying is associated with the heavier densities and with lower deflection. The manufacturers claim that a mat of 4 lb per cu ft density can be deflected 74% of its thickness at a load of 25 psi, without lateral bulging, and return to its original thickness immediately when the load is removed. The material shows true elasticity in that the amount of deflection follows the loading, the material returns immediately to its original dimensions when the load is withdrawn, and the cycle is

(*Continued on page 180*)

wherever you need stainless steel tubing...

TRY TRENTWELD!

● Stock lines in food, paper, and chemical plants; heat exchanger units in processing industries; cooling coils in breweries, beverage industry, dairies and dairy equipment...throughout all industry, wherever there's a stainless or high alloy tubing application, there you'll find TRENTWELD.

And it's to be expected! TRENTWELD is made in a tube mill by tube engineers who roll and weld stainless and high alloy tubing exclusively. Then too, TRENTWELD is available in a full range of sizes — ⅛" to 40" in diameter. This, coupled with Trent's convenient mid-continent location, means prompt delivery of what you want ...when you want it. If yours is a stainless or high alloy tubing requirement: Call on us.

TRENTWELD

STAINLESS STEEL TUBING

TRENT TUBE COMPANY, GENERAL SALES OFFICES, EAST TROY, WISCONSIN

(Subsidiary of Crucible Steel Company of America)

Investigate

STAR

Custom Porcelain Specialties

wherever your applications call for Resistance to

- **ELECTRICITY**
- **HIGH TEMPERATURE**
- **MOISTURE**
- **THERMAL SHOCK**
- **CHEMICALS**

★

THERMOLAIN
An excellent example of end usage is described at the right.

VITROLAIN
Strong, dense, low porosity porcelain with superior dielectric and mechanical strength.

LAVOLAIN
Steatite — strong, dense, heat resistant insulation with good mechanical strength and thermal shock resistance.

No. 921 INSULATION
Hard, stoneware type ceramic with outstanding thermal and electrical properties.

NU-BLAC
Same good dielectric and mechanical strength offered by STAR Commercial White—and does not soil in assembly.

HUMIDOLAIN
Highly porous, special clay body widely used in deodorizers, humidifiers and air conditioning equipment.

STAR PORCELAIN gets the call for Cavalier heater units

These tapered, hollow cones (9" high) in Cavalier electrical room heaters are made of Cordierite ceramic (STAR THERMOLAIN), a refractory especially designed for this use. Cavalier has found that THERMOLAIN provides the exceptional strength and excellent heat-shock resistance essential for high performance of this fine unit.

STAR THERMOLAIN is used extensively for all types of electrical heating appliances and equipment where rapid changes of temperature occur. And it is only one of many STAR porcelain products that meet a wide range of requirements. For help on any ceramic insulation problem, call on STAR engineers for a practical solution.

Star

PORCELAIN COMPANY

39 Muirhead Avenue • Trenton 9, N. J.

New Glass Fiber Mat . . .

continued from page 178

reproducible accurately up to the fatigue limit, and therefore predictable.

The characteristics of the mat in any given density can be changed by treatment before use. By a process of preloading the material, the deflection under applied load can be decreased to other repeatable values, so that the material can be modified for a wide variety of specific conditions. The glass fiber mats have excellent durability under repeated loading, and in tests have been loaded to 25% deflection and unloaded for a million cycles without perceptible decrease in load-carrying capacity.

Applications

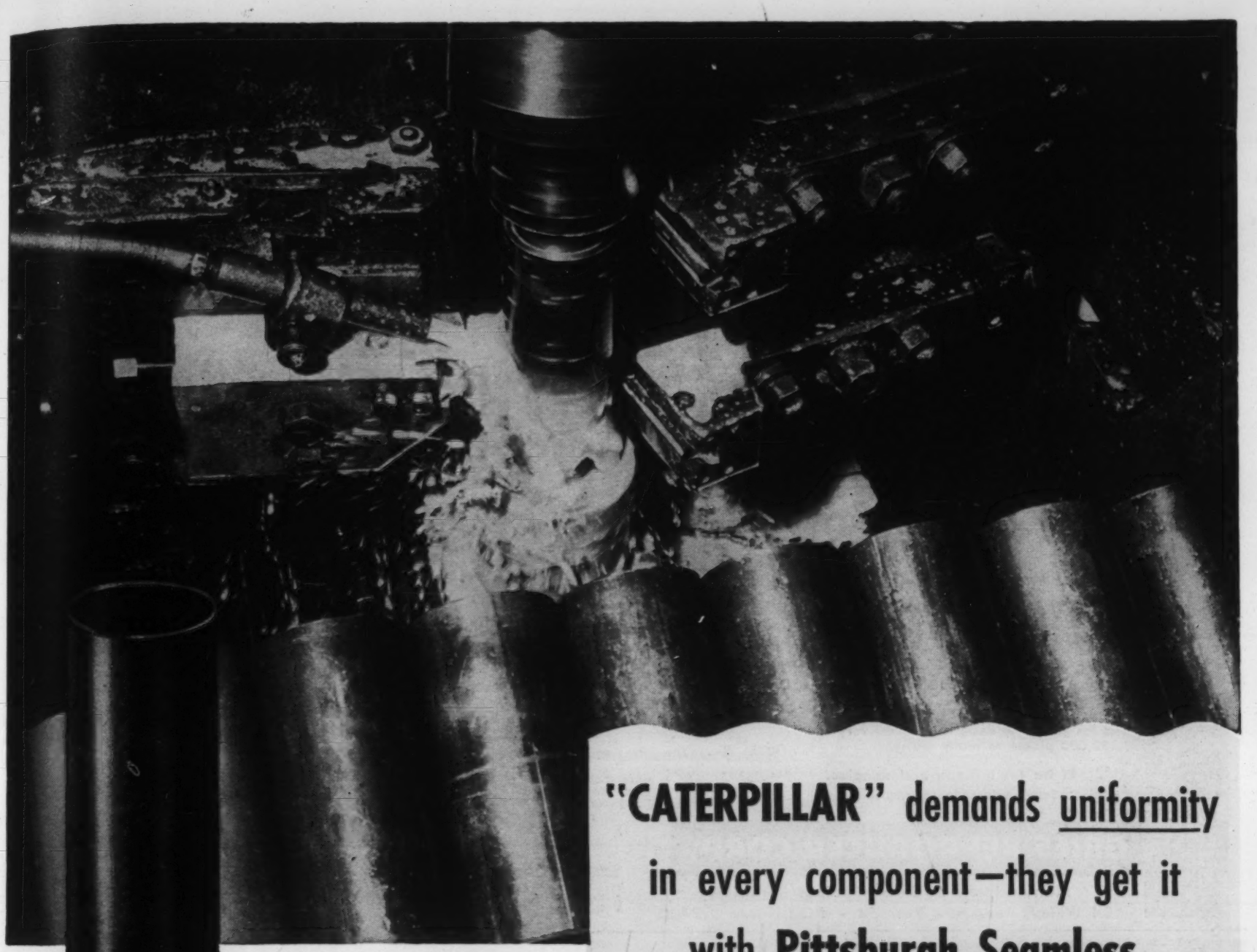
As stated, the bonded glass fiber mat was originally produced as a resilient material for an ordnance item. It has found use, or is being considered, for such parts as cushioning pads in the shipment of delicate instruments or fragile components, for vibration-absorbing mounts for motors, for resilient mounts for heavy machinery, for lightweight, shock-absorbing mounts for aircraft motors, and for aircraft instrument and radio mounts, for airseal strips, for muffling of vibration noises in forced-air furnaces, and for protection of small electric motors. The bonded mat is lower in cost than sponge rubber, its producers say, it is about the same in price as rubberized hair, and slightly above the cost of cork.

The mat is approved under Military Specifications MIL-C-17435 (Bu Ord), for resin-bonded fibrous glass cushioning material.

Now

U. S. DEFENSE BONDS

EVEN BETTER



"CATERPILLAR" demands uniformity in every component—they get it with Pittsburgh Seamless Cold-Drawn Tubing

The uniformly excellent performance of "Caterpillar" built products is no mere chance. They get it by insisting on uniformity in every component of their equipment. For example, thousands of the track pin bushings shown being machined above are made of Pittsburgh Seamless Cold Drawn Tubing. It has the necessary size accuracy and finish to facilitate machining—the uniform physical properties that make big, high-speed production runs possible. The result is that the parts made from Pittsburgh Seamless have the consistent high quality found in all "Caterpillar" built products.

For a uniform, free machining cold-drawn mechanical tubing that helps improve your products—speed production, specify Pittsburgh Seamless.

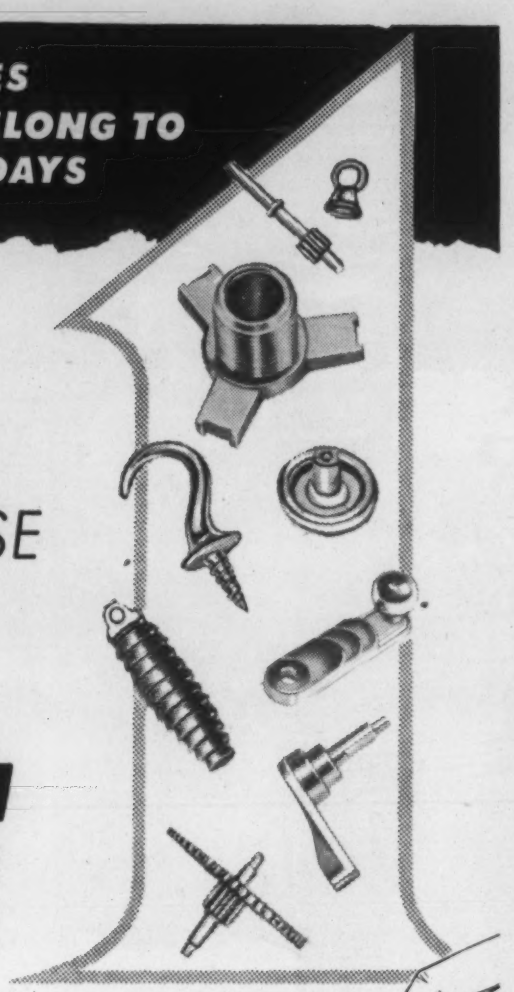
Pittsburgh Seamless Cold Drawn Tubing

***a product of* Pittsburgh Steel Company**

Grant Building, Pittsburgh 30, Pa.

MULTIPLE ASSEMBLIES
FOR SMALL PARTS BELONG TO
HORSE-AND-BUGGY DAYS

GRIES
DIE CASTINGS
GIVE YOU TINY
PARTS LIKE THESE
COMPLETE
IN **ONE**
OPERATION



Compare GRC small die castings with assemblies produced by other methods. GRC completely finished parts save you time, labor, money. Cast in one high-speed operation, they open broad opportunities for your new designs. Fast delivery on 100,000 pieces to many millions.

Write for bulletin and samples.
Send prints for quotations.

America's Foremost *Producers* of Tiny Die Castings

GRIES REPRODUCER CORP.

Manufacturers of Small Castings Exclusively
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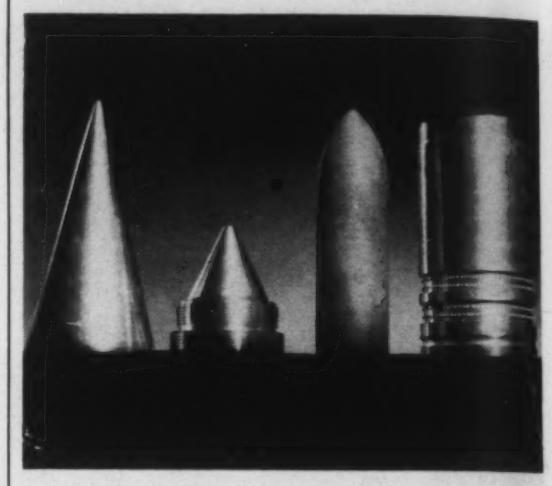
Smallness Unlimited
Max. Wt.: ½ oz.
Max. Lgth.: 1¾ in.

News Digest

sonar, communication and other types of military equipment. Boro-silicate tubing is used for medical and pharmaceutical purposes and for industrial piping in chemical and food-processing plants.



***TUNGSTEN CARBIDE CORE** which gives the sock to present-day anti-tank shells went from G-E's Carboloy Dept. laboratories to the production line in just two weeks back in 1944. Dramatic story of lightning-fast cooperation among several manufacturers, the Army and the Navy after our advance in Europe had been slowed by heavy-armored Nazi tanks was revealed recently for the first time. Left to right above: windshield, nose piece, core and body (less rotating bands).*

Machining Conference Set

A panel discussion on "Hard to Machine Materials" will be held at Purdue University, Lafayette, Ind., on Apr. 18.

Five industrial experts will partipate in the panel, which is part of a one-day Tool Engineering Conference sponsored by Indiana chapters of the American Society of Tool Engineers.

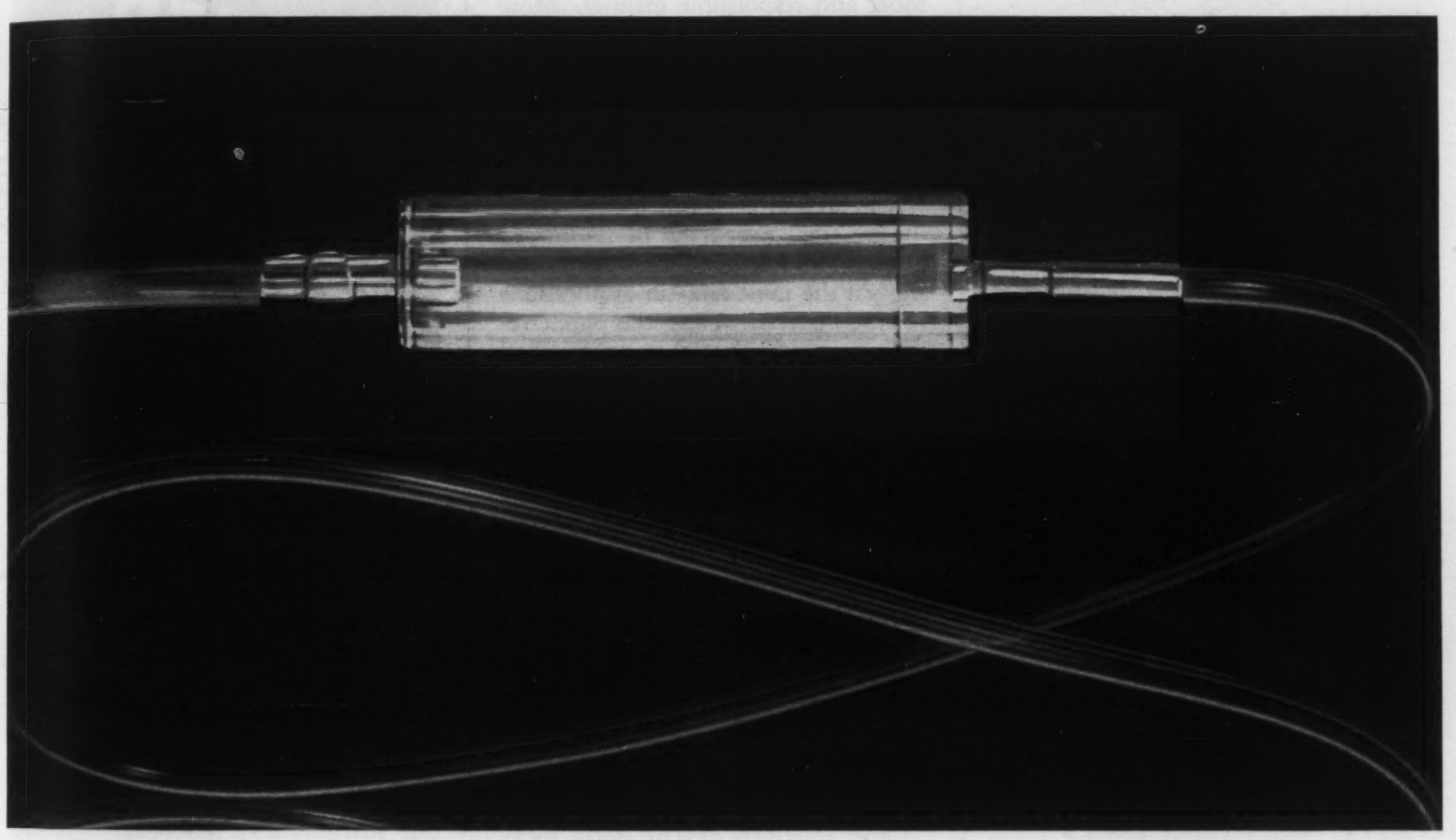
The meeting, scheduled in line with the ASTE national education program, will also feature a report of research on grinding of geometric sections and a tour of the University's new million-dollar machine tool laboratory.

(*More News Digest on page 205*)

DOW

THERE IS A STYRON FORMULATION AVAILABLE FOR EVERY PURPOSE

STYRON 700 withstands high heat sterilization . . . it is one of several STYRON formulations



Styron® 700 is a high-heat resistant polystyrene that meets the requirements of low cost necessary for an expendable appliance like this Saftiset Blood Filter Unit. Styron 700 has a heat distortion temperature of 20° F. higher than general purpose polystyrene as measured by A.S.T.M. methods. Styron 700, when properly molded on standard injection molding equipment, produces products that can resist temperatures as high as 220°F. before signs of distortion. This Styron formulation is also readily extrudable with high surface gloss and close dimensional tolerances. Extrusion equipment designed for polystyrene is well suited to Styron 700.

In addition to Styron 700 Dow offers a variety of polystyrene formulations that covers a wide range of characteristics. *STYRON 475* is a rigid, tough thermoplastic characterized by a combination of unique physical properties. *STYRON 637* is a light-stabilized grade of polystyrene that readily finds application in lighting fixtures. *STYRON 666* is an excellent general purpose polystyrene developed to provide maximum property values in the end product with maximum ease and speed of fabrication. *STYRON 777* is a medium impact polystyrene with desirable cost and fabrication advantages.

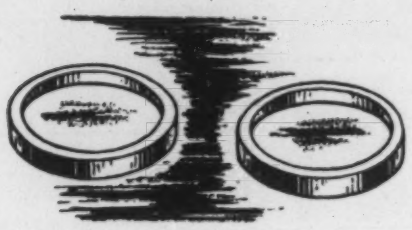
A number of technical service bulletins are available for more detailed information on the Styron formulations. Write THE DOW CHEMICAL COMPANY, Midland, Michigan, *Plastics Department PL1410B.*

you can depend on DOW PLASTICS

DOW

WHY PAY FOR MAKING A HOLE?

If you make an item like these valve seat inserts, give a thought to using Murray tubing. Formerly *machined* from bar stock, they cost 18 cents to produce. Now they are literally *sliced* from Type 304 stainless tubing for a dime apiece.



Where the "hole" is important, don't pay for transportation, storage and labor to make it. Consult our tubing specialists about getting it for free.

Other Murray products include carbon steel tubing and pipe for mechanical and pressure purposes; Welding and screw type pipe and tube fittings. Tube bending, upsetting, swaging.

WRITE FOR CURRENT STOCK BULLETIN

A B MURRAY CO INC
ESTABLISHED 1845
ELIZABETH, N. J. McKEESPORT, PA.

News Digest

Reinforced Plastics . . . .

continued from page 8

them were there to find out what reinforced plastics could do for their products.

A disinterested observer assessing the temper of the three-day meeting could not help but feel that the "infant" was showing signs of maturity beyond its years and size. Reinforced plastics are being pioneered by an exceptionally enthusiastic group of scientists, engineers and marketers, but in what seems to be a remarkably sober and responsible manner. More and more, the importance of proper materials selection, careful design and comprehensive testing before full-scale production are being emphasized. Whimsical replacement of metals in consumer products has given way to an approach which emphasizes the inherent properties of reinforced plastics and allows these properties to suggest the most fruitful applications for the material. Thus, the public resistance which plastics in general had to overcome because of the irresponsibility of some molders in making inappropriate substitutions for metal during the war years is unlikely to recur in the case of reinforced plastics.

New Directions

This is not to suggest that the industry is shy about branching out into new fields. It is already evident, for instance, that the plastics molders have designs on what, for many years, has been the all-porcelain-enamel bathroom. Wash basins, toilets and tubs of glass-polyester were shown by several companies.

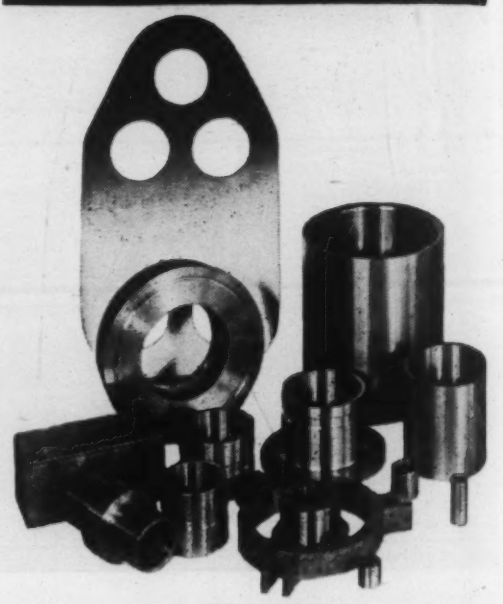
Other relatively new products, some still in the development stage, were a burial casket, a lead-acid storage battery case, traffic signs, pressure water tanks, a chromium-plated car bumper and a safety baseball cap.

Of particular interest were three "firsts" in connection with familiar consumer items:

Plastics Luggage

1. The first complete line of competitive-priced plastics luggage has been molded for the Saberly Products Co. by General American Transportation Corp. The line features five sizes and five different colors in a swirl finish. The 21-in. suitcase weighs about 4 lb.

2. The first complete plastics refrigerator liner has been molded by Structural Plastics Corp. for the Crosley Div. One of the goals of the in-



American Crucible methods, experience, know-how and equipment result in highest quality. . . . . .bearings that carry a

MONEY-BACK GUARANTEE OF LONGER SERVICE AND LOWER MAINTENANCE COST

PROMET
THE Engineered BRONZE

BEARINGS • BUSHINGS
WEARING PARTS

Machined or Rough Cast of the Specific Formula Best Suited to the Application. Write for literature or send blueprints, conditions of operation, etc. for quotations and recommendations as to alloys.

THE AMERICAN CRUCIBLE PRODUCTS CO.
1325 Oberlin Ave., Lorain, Ohio, U. S. A.

Case History MM-105

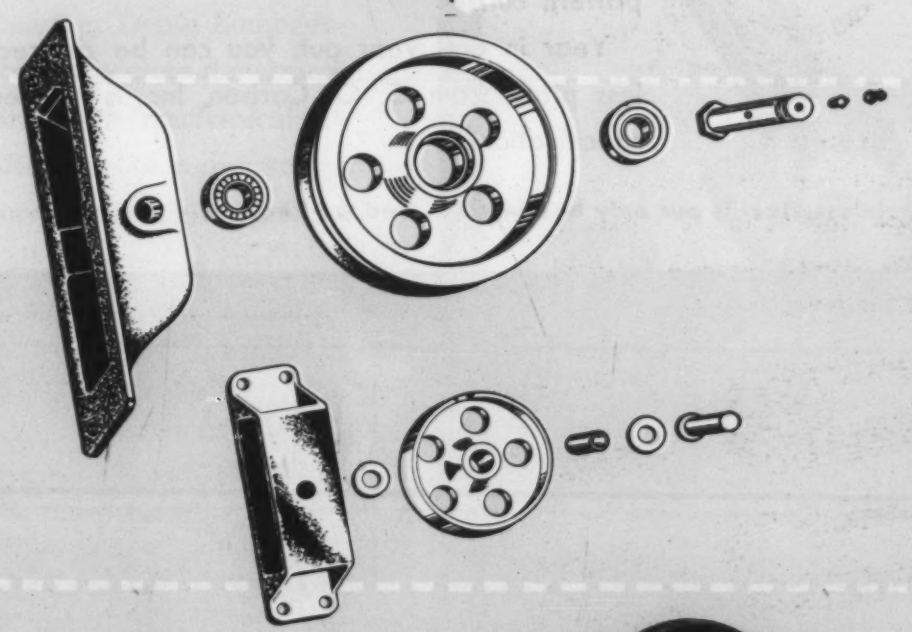
Here's what we mean by SUPERIOR ENGINEERED FOUNDRY PRODUCTS...

PROBLEM:

A manufacturer needed a source of supply capable of designing, machining and assembling complete mechanical units ready for field installation; in this instance, hangar-door hardware.

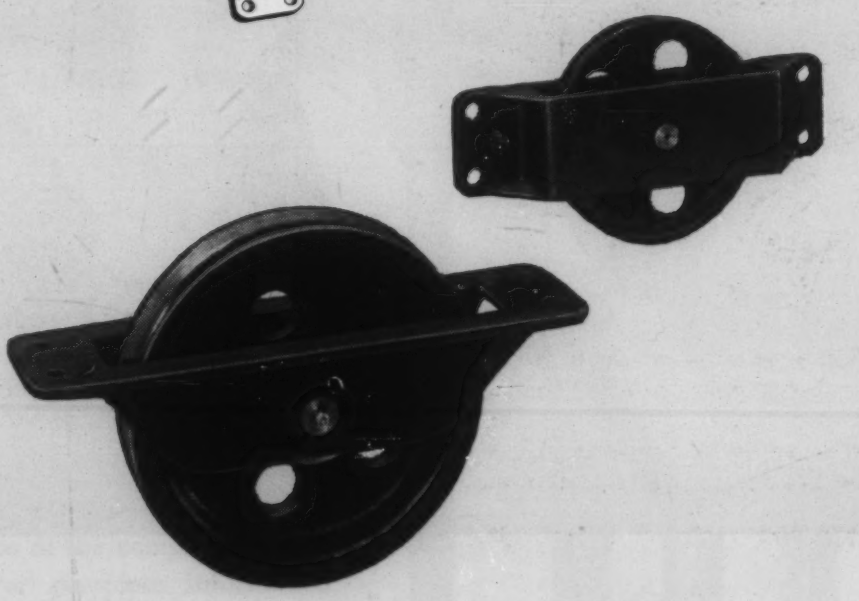
SOLUTION:

SUPERIOR FOUNDRY ENGINEERED DESIGN castings in malleable iron . . . machined, assembled, packaged and shipped complete, ready for installation in the field.



RESULT:

No costly designing, machining and assembly problems for the manufacturer ...plus a packaged assembly easy to install in the field for satisfactory service.



You, too, can get advantages like these! Consult our PRODUCT DEVELOPMENT SECTION regarding your problem . . . while it's still in the planning stage.

ENGINEERED FOUNDRY PRODUCTS

Since 1916

LET OUR FOUNDRY ENGINEERS HELP YOU CONSERVE CRITICAL MATERIALS

SUPERIOR STEEL AND MALLEABLE CASTINGS CO.

BENTON HARBOR, MICHIGAN, U. S. A.

an

ODD SHAPE *in*

stainless plate?

Not at G. O. Carlson, Inc., for our complete service in stainless plate items is backed up by special cutting equipment and techniques which have been developed and refined over the years. "Odd" shapes are routine at G. O. Carlson, Inc.

While many of our customers purchase their stainless plate in sheared rectangles, many others prefer that we ship their orders cut to pattern. Valuable time, labor and critical material are conserved by specifying that plate be pattern cut.

Year in and year out, you can be assured that stainless plate from G. O. Carlson, Inc. is delivered to your specifications.

Stainless steel is our only business . . . and we know it.

G. O. **CARLSON, INC.**

Stainless Steels Exclusively

Thorndale, Pennsylvania

PLATES • FORGINGS • BARS • SHEETS (No. 1 Finish)

District Sales Offices in Principal Cities

News Digest

dustry is a complete plastics refrigerator, and this is the closest it has come so far.

3. The first plastics-body automobile to be definitely scheduled for production was exhibited by Kaiser-Frazer. The new low-built sports car will be in production in July. (This development is discussed in more detail in an article on p 190).

Many current and projected applications of reinforced plastics were described by representatives of the armed forces who attended the meeting. A summary of new defense applications will be found in the following section.

Plastics for Defense . . .

It is no secret that a large proportion of reinforced plastics production today is going into defense work. What is secret is the exact nature of much of this work.

However, government interest in reinforced plastics covers many fields and includes many unclassified projects. More than a dozen government representatives appeared before the recent Washington conference to outline their current interest in reinforced plastics. Specific projects, with considerable emphasis on seagoing applications, were discussed by representatives of the Bureau of Ships, the Coast Guard and four branches of the Army, including Transportation, Engineers, Signal and Ordnance.

Boats Over 100 Ft

According to K. Telford Marshall of the Transportation Corps' Research and Development Station, Ft. Eustis, Va., "the so-called ideal plastic reinforced building material or method of fabrication is a long way from being realized. However, (present) materials and methods can be utilized to build vessels ranging up to 100 ft that provide more desirable characteristics than any other known material."

Among the reinforced plastics items being purchased, tested or developed by the Transportation Corps are:

1. An 18-ft Arctic ice skiff.
2. A 26-ft utility boat 1600 lb lighter than the wood version and having 25% greater load capacity.
3. Hopper-type barges 50 and 100 ft long.

Still in the preliminary investigation stage are box cars, locomotive cabs and the lower fuselage section of the Army's helicopters.

(*Continued on page 189*)

News Digest

Replaces Monel

The Coast Guard is now service testing 40-ft utility boats made of reinforced plastics, and will shortly begin evaluation tests on 60-gal water tanks and evaporator shells where the glass-polyester material is being substituted for monel metal.

A somewhat cautious approach was acknowledged by Capt. C. E. Brush, Chief of the Coast Guard's Testing and Development Div.:

"The use of reinforced plastics will undoubtedly receive consideration for applications other than those mentioned, and as more experience is gained with them there will be less hesitation in considering them than there seems to be at the present time."

One of the most ambitious programs of utilizing these materials is being carried out by the Bureau of Ships. This agency is currently procuring dinghies and wherries up to 16 ft, rescue and whale boats up to 26 ft, and experimental 36-ft LCVP's.

Subs and Minesweepers

Among the many diverse uses being investigated by the Bureau of Ships are:

1. A 57-ft minesweeper, and a minesweeper float.
2. Tanks up to 4150 gal for shipboard storage of water and diesel oil at a structural weight saving of 40%.
3. Decking for submarines, and a fairwater for subs to replace the present aluminum component which causes galvanic corrosion at its junction with the steel hull.
4. Parts of ship supersturcture to eliminate radio interference and make possible a lower antenna.
5. High-pressure storage cylinders to withstand a proof stress of 3000 psi and working stress of 1800 psi.
6. Shipboard piping.

Landing Mats

Two items for which the Corps of Engineers has been assigned responsibility appear to be moving toward acceptance. Detail drawings of a plastics assault boat are now in preparation. Progress on the development of plastics landing mats for aircraft appears to be somewhat less satisfactory, but there is hope that a mat with preformed inserts will do the job.

The Signal Corps has adopted reinforced plastics for several structural applications but has tended to steer clear of electrical applications so far.

According to E. M. Beekman and A. Rusch of the Engineering Labora-

TWO MILLION WITHOUT A FAILURE!

parts: small connecting rods

alloy: "600" series metal, a high strength bearing bronze that contains no tin

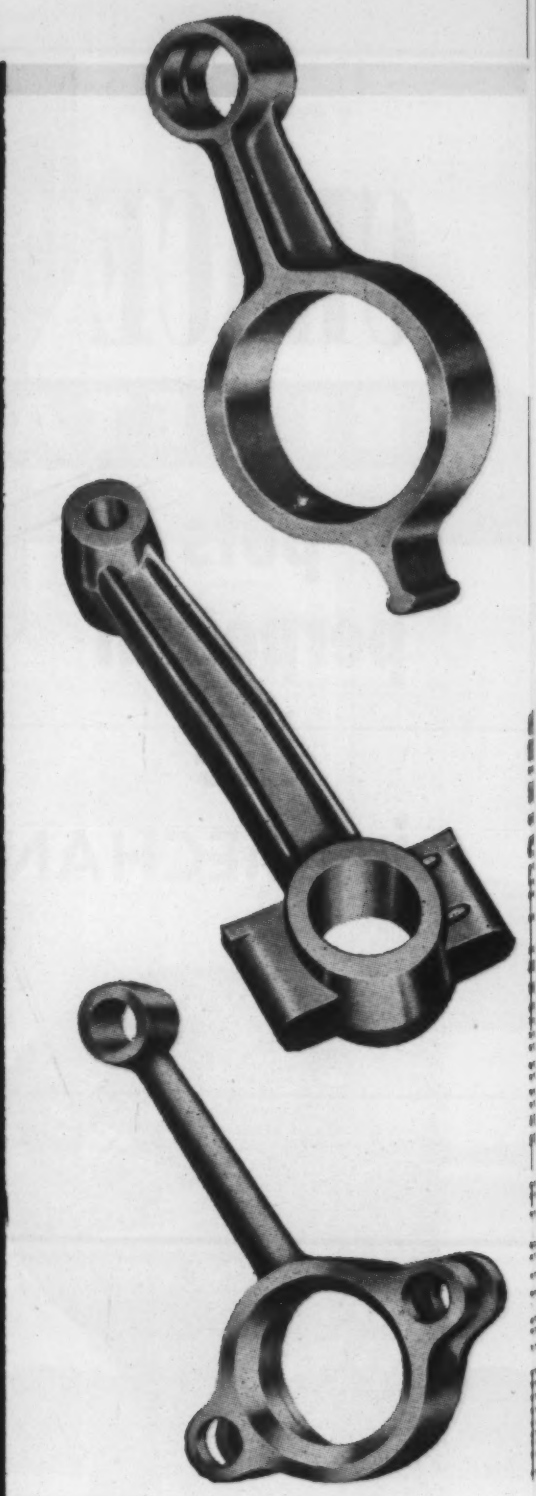
quantity to date: over 2,000,000

number of failures: none

forged by: Mueller Brass Co.

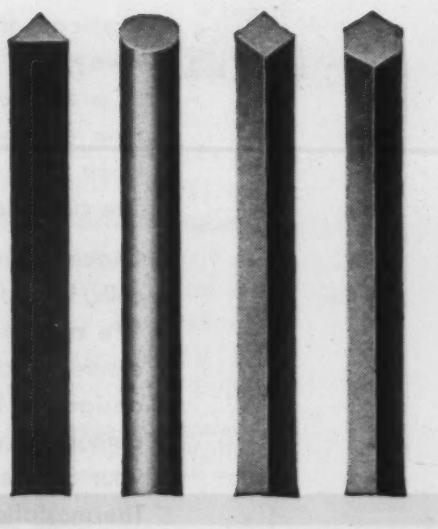
advantages: no bearing insert is necessary on either the wrist pin or crankshaft end because each rod acts as its own bearing. Dense homogeneous grain structure, close dimensional tolerances and high mechanical properties often permit redesigning for weight savings as high as 15% to 25%. "600" alloys have low coefficient of friction, high resistance to corrosion and tensile strength 2½ times greater than cast phosphor bronzes.

uses: compressors, outboard motors, small high speed gasoline engines. Best results are obtained if they operate against hardened, ground and polished shafts.



"600" SERIES ROD is produced in standard 12-ft. mill lengths and a wide range of sizes and special shapes. This rod has a fine, uniform grain structure and the mechanical properties are rigidly controlled in the cold drawing process. Scrap loss is greatly reduced in machining operations because of the complete absence of defects. For complete information, write us today.

104

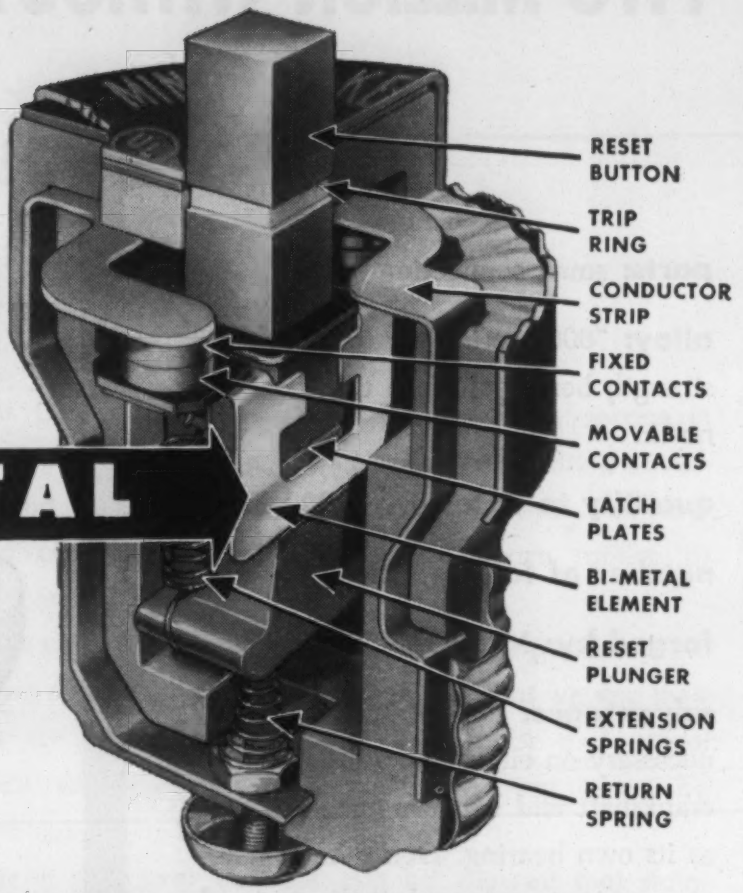


MUELLER BRASS CO.
PORT HURON 16, MICHIGAN

CHACE

BIMETAL

puts perpetual life in MECHANICAL PRODUCTS' MINI-BREAKER®



Product of Mechanical Products, Inc. Jackson, Mich.

The Mini-Breaker, manufactured by Mechanical Products, Inc., is a plug type circuit protector that provides positive, permanent protection against overloads and short circuits in electrical appliances and the wiring of residential or commercial buildings. Mini-Breakers are installed in Edison base fuse sockets and are built in 15, 20, and 30 ampere ratings. The trouble-free actuating element is largely dependent upon Chace Thermostatic Bimetal.

Under normal line conditions, electric current passes through the Conductor Strip and the Chace Thermostatic Bimetal actuating element, which carries a pair of movable contacts. On a direct "short" or a sustained overload, the excessive heat generated causes the element to bend away from the latch plates on both sides of the center reset plunger. A preloaded return spring then forces the plunger outward while twin extension springs pull the element and the movable contacts back . . . away from the fixed contacts . . . thus breaking the circuit. The circuit is restored by pressing in the reset button.

Chace Thermostatic Bimetal is manufactured in 29 types, in strips, coils, random long lengths and welded or brazed sub-assemblies. We also provide specialized tooling necessary to fabricate bimetal elements to customer designs. Before proceeding with your next design, we invite you to consult our Application Engineers, recognized authorities on temperature responsive devices—or write today for your copy of our 32-page booklet "Successful Applications of Chace Thermostatic Bimetal," containing condensed engineering data.

IT BENDS WITH THE HEAT

W. M. CHACE CO.
Thermostatic Bimetal
1615 BEARD AVE., DETROIT 9, MICH.

News Digest

tory, "Signal Corps engineers are enthusiastic regarding the potentialities of low pressure reinforced plastics in applications for which physical and mechanical characteristics are of primary importance, but, in instances in which electrical characteristics are the deciding factor in the selection of material, it is believed that a cautious approach is advisable until methods of fabrication have been more completely standardized and a greater number and variety of performance tests have been analyzed."

Antenna masts up to 60 ft high are already in use by the Signal Corps. Interest also centers on shelters for radio direction finders and on the possibility of replacing hard rubber in lead-acid storage battery cases and cell covers.

Rocket Launchers

A variety of heavy-duty items are also being explored by the Ordnance Corp. Among these are:

1. Ammunition boxes for parachute delivery.
2. A trailer-mounted water tank for field use.
3. Hard tops for jeeps and truck cabs.
4. Rocket-launchers and mortar base plates.
5. Gasoline tanks.

Promise of expanding applications was indicated by Gerald Reinsmith, Chief of the Nonmetallic Structural Materials Unit, and Hary E. Pebly, Jr., Chief of the Plastics Laboratory Fabrication Unit at Picatinny Arsenal:

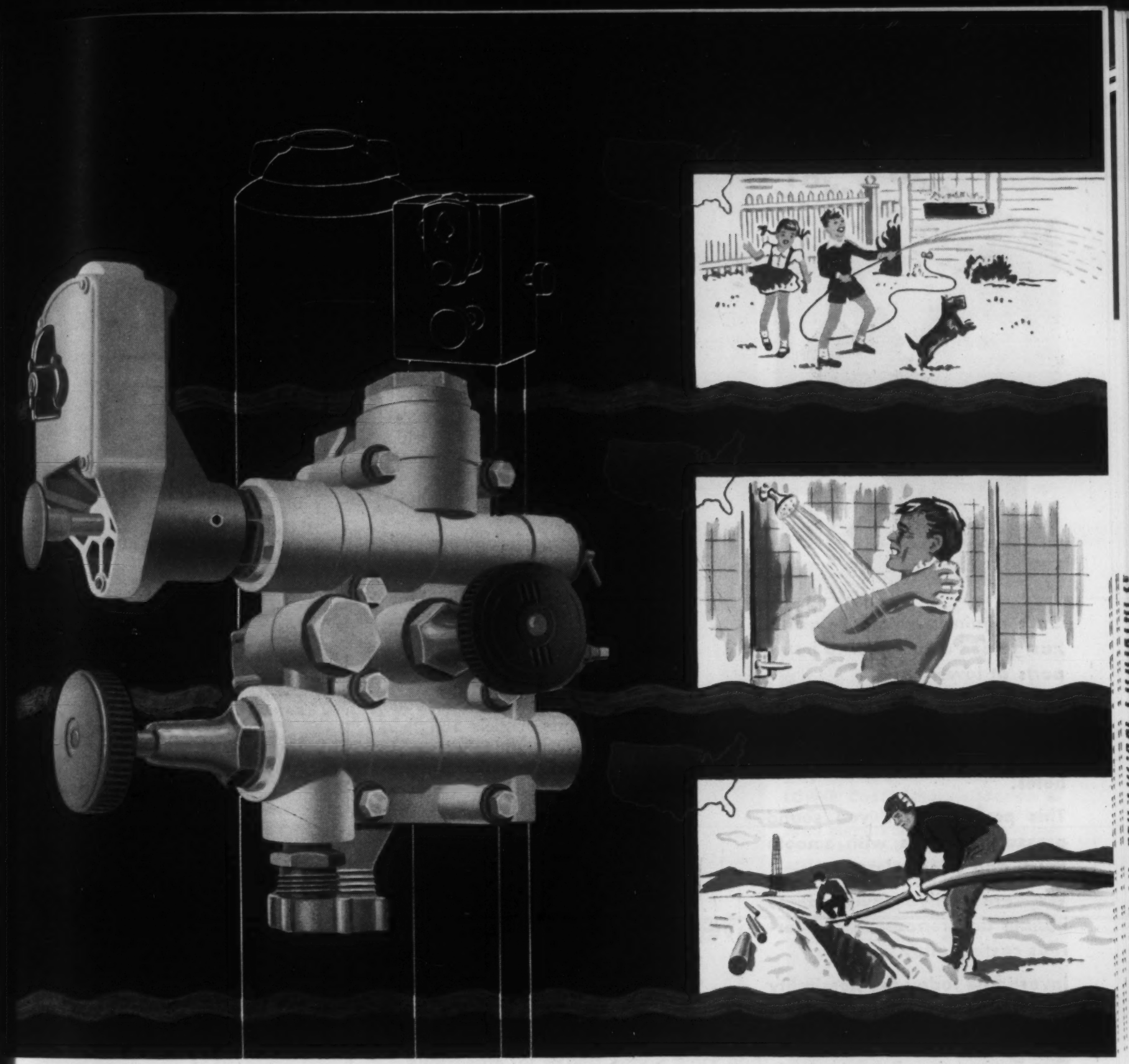
"The Ordnance Corps plans to continue the use of reinforced plastics wherever their merits as an engineering material permits. To our minds, they are not substitutes, but are instead important engineering materials that provide attributes not attainable in other materials."

Auto Bodies . . .

Two major auto producers will have plastics-body sports cars on the market shortly.

Already in production is Chevrolet with the Corvette, which made its first appearance at the GM Motorama in January. The Corvette is 33 in. high and 70 in. wide on a 102-in. wheelbase. It weighs slightly less than 3000 lb and packs a stepped up 160-h.p. engine.

Scheduled for July production is Kaiser-Frazer's DKF-161 which made



Look how Kralastic *helped solve the 'hard' water problem!*

"Hard" water is hard on a lot of things —on face, hands, clothes, and even on the pipes and valves it runs through!

The Lindsay Company—America's largest maker of automatic home water softeners—had to keep the water from eating away at the water softener itself!

But **Kralastic more than licked the problem!** Valves molded of this unusual rubber-resin blend are unharmed by the hardest water. They resist salts, acid solutions, and other chemicals that lurk in water.

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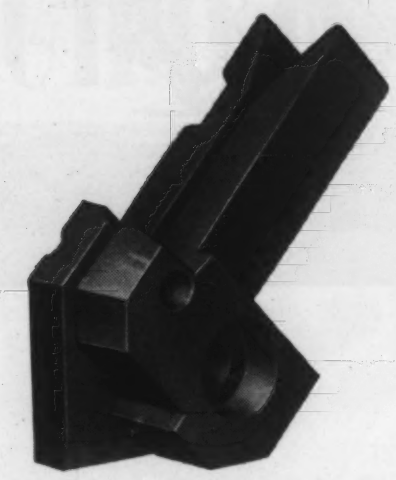

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a February debut in Washington. It measures 15.3 ft from bumper to bumper, is 69 in. wide and stands 36 in. high. The Kaiser model weighs slightly over 2000 lb and develops slightly over 100 hp.

Both cars are smartly styled and feature smooth, clean lines. In both, the body material used is polyester-glass. According to Kaiser's chief engineer, George Harbert, material thickness will range from 1/8 to 3/16 in., except where it must be built up for attachments.

First in Production

More than a dozen molders have displayed prototype plastics auto bodies in the past year or so, but Chevrolet and Kaiser are the first auto-makers to schedule plastics-body cars for production.

Kaiser plans to produce about 2000 of its new sports models and then cease production pending full service evaluation of the car. Chevrolet has been more reticent about its plans, but it is believed in the industry that not more than a few hundred Corvettes will be made with plastics body before production is switched to the conventional steel body.

An interesting sidelight: although a reinforced plastics bumper is considered quite feasible by most molders, Kaiser's first production line models, at least, will feature conventional chromium-plated steel bumpers.

No Trend Yet

The advent of the plastics-body sports car does not mean that plastics auto bodies are just around the corner for the garden variety of American car. Present fabrication techniques in plastics could not possibly keep up with the production rates required to meet consumer demand, to say nothing of the tremendous current difference in price between sheet metal and the constituents of reinforced plastics. But some engineers *are* looking forward to the day when reinforced plastics may see general use in automobiles.

One of them is Games Slayter, vice president in charge of research, development and engineering for Owens-Corning Fiberglas Corp. In January, at the annual SAE meeting in Detroit, he told the automotive engineers he thought reinforced plastics would replace metals in many automotive applications within a few years time.

To back up this statement he cited

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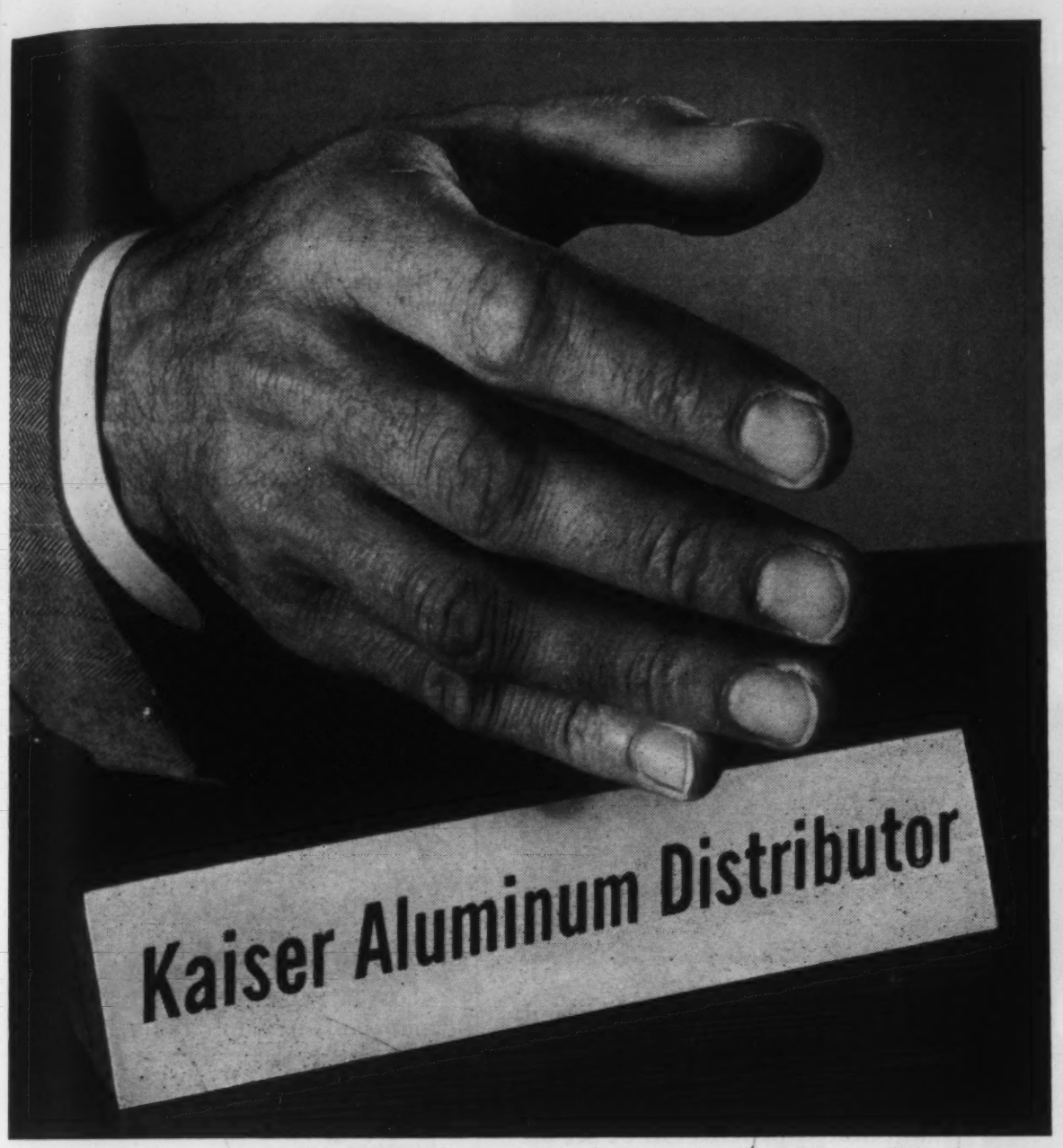

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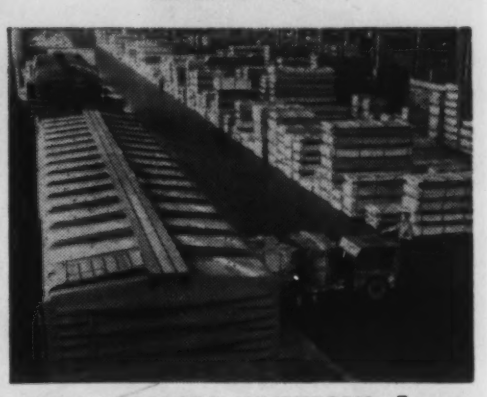

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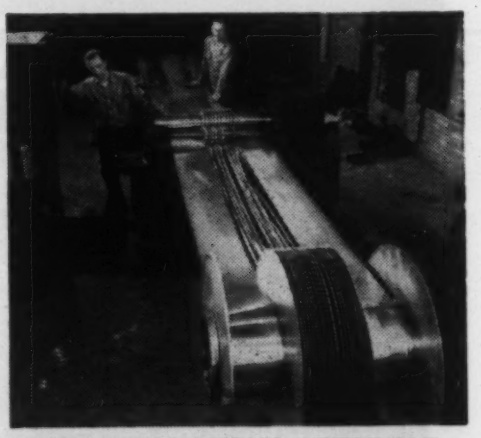

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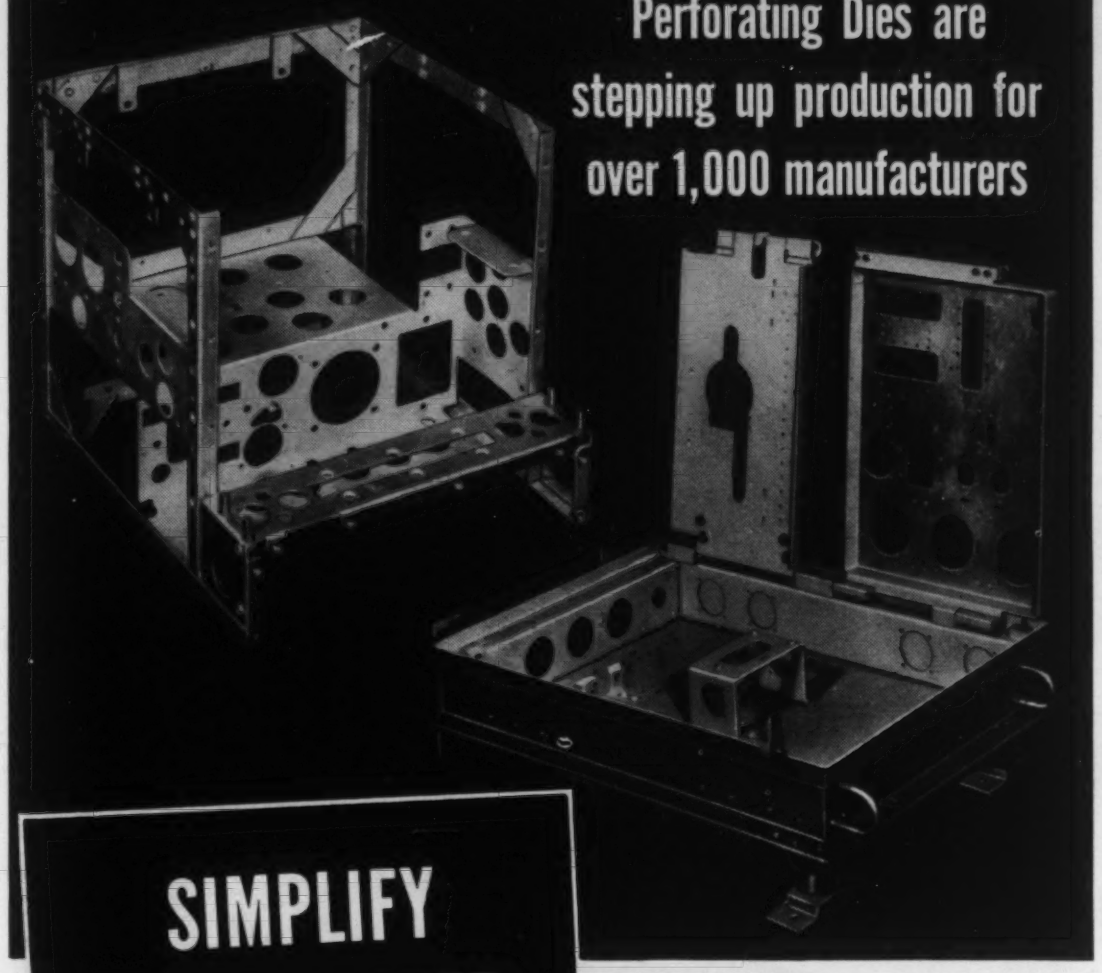

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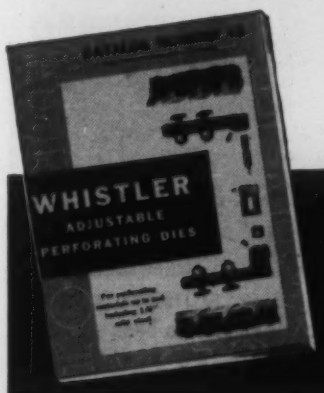
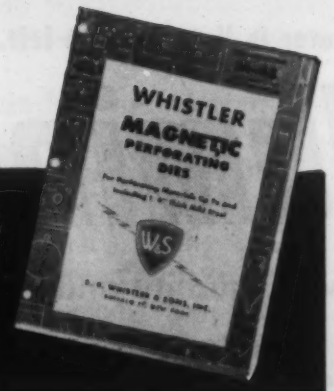


For prices and application data on this modern way to speed production and cut unit costs, write for these illustrated Whistler catalogs.



News Digest

a number of technical and economic factors.

Prices Compared

In the form of mats and rovings, he said, "fibrous glass is priced at 40 to 50¢ a lb—and for equal strength, glass reinforced plastics can replace steel 1 lb for three or four. It can replace aluminum in the ratio of 2 lb of glass reinforced plastics to three of the metal. These ratios can be improved upon by designing around the modulus of elasticity of the glass-resin combination."

He added: "Processes are in development now which should reduce the cost of glass even more, and if the demand develops, plastics, too, can meet the price scale; some of them, suitable for many purposes, already are in the range of 18 to 25c a lb."

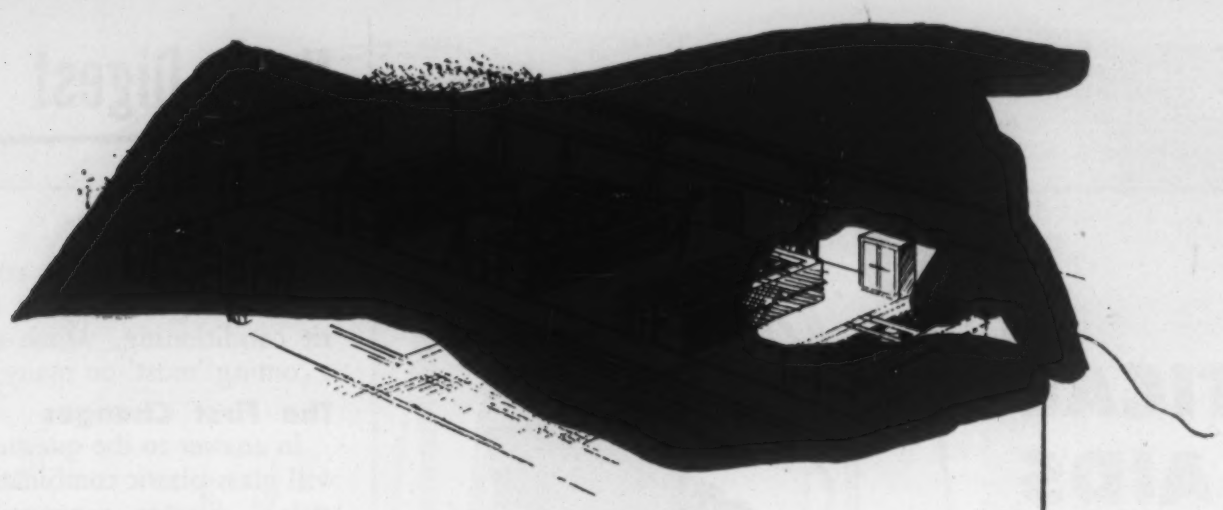
Slayter referred to the versatility in properties of glass-plastic combinations obtained by changing ratios of mixture and the form in which the glass is supplied. "In the case of bumpers", he said, "the use of a unidirectional glass strand system, plastic impregnated, gave impact results better than the conventional steel bumper."

Safety and Repairs

The problems of safety and repair costs also received attention. Slayter believes that reinforced plastic construction would cut auto repair costs in half on fenders, trunk lids, body panels, dashes, and the like. He gave two reasons: (1) the same type of impact absorption that is used in the new body armor in Korea can be built into the body structure, and (2) the glass-plastic material will puncture or crack (not collapse) when sufficiently hit; thus, it can be repaired by heat and patching, instead of being bumped out with dies, shapes and hammers.

He thinks this has some importance with regard to safety. In addition to the advantages of damping power, the different type of failure tends to avoid the danger of the occupant being trapped by collapsed metal structure.

As for comfort, Slayter points to the possibilities of better air conditioning. Not only does the poor thermal conductivity of the material make it more comfortable to the touch in hot weather but, he adds, "where the 'hard-top' is made of glass and plastic, the light transmission is pleasant



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Into the limbo of lost atoms go all aircraft cylinders, as their usable bore limits are reached. But why scrap them? Replace the lost atoms and the cylinders are new again!

That's the Van der Horst answer to wear. We use PORUS-KROME*, to put back atoms that last twice as long as the kind they replace.

For ten years in this way, the armed services have cut costs — and improved engine efficiency. Now, PORUS-KROME cylinders are standard in *new* aircraft engines, as well.

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* *PORUS-KROME is a dense, hard, wear and corrosion-resistant chromium, produced by the Van der Horst Corporation of America, and which gives working surfaces an infinite number of tiny oil-retaining reservoirs for perfected lubrication.*

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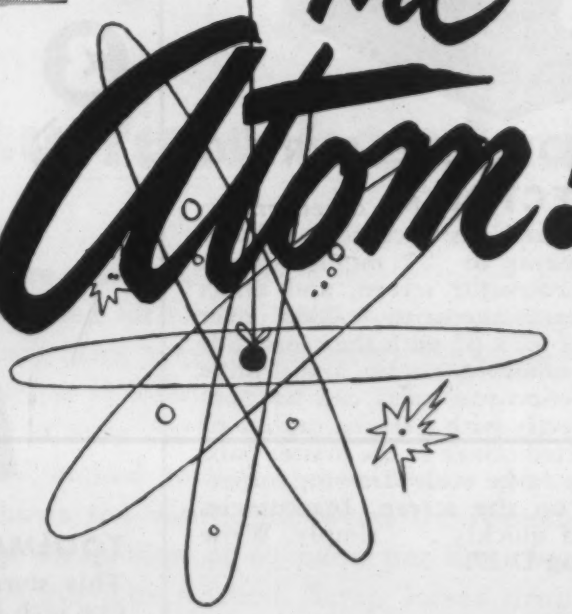

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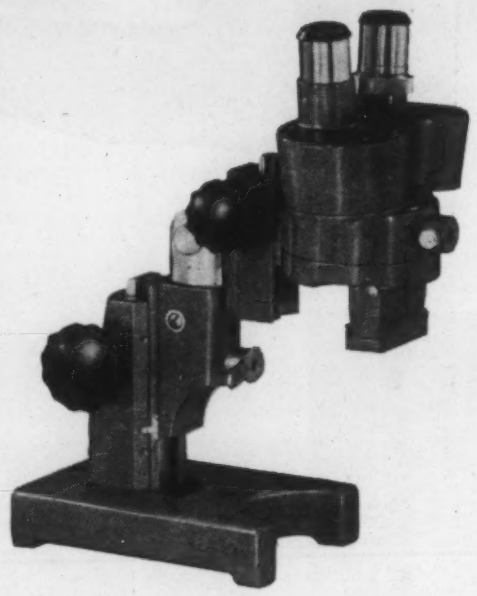

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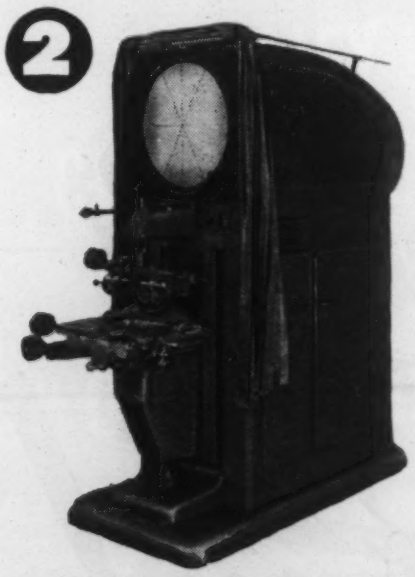

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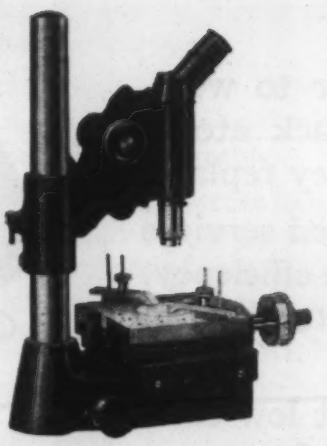

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This sturdy microscope gives you one inch linear measurements to ± .0001″ and angular measurements (with protractor eyepiece) to ± 1 minute of arc. Operation is extremely *simple* and *fast.* Opaque and transparent objects of any contour can be measured. Catalog D-22.

WRITE for complete information on these three important optical aids designed to save you time and money. You may be paying many times over their moderate cost in lost time and rejects. Bausch & Lomb Optical Co., 79316 St. Paul St., Rochester 2, N.Y.

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and the sun's heat is resisted. The whole thing may make for simpler air conditioning, which seems to be a coming 'must' on many models."

The First Changes

In answer to the question: "Where will glass-plastic combinations replace metal", Slayter suggested housings, wheels and certain structural members to reduce unsprung weight; springs; exterior panels; fenders; bumper guards; the dash assembly; sills; trim and moldings; the top, trunk and deck; certain gears; molded parts; hose connections; etc.

Turning from the optimistic view, Slayter took a look at the problems confronting the immediate adoption of this material. He found two principal difficulties: the limited heat distortion level and molding speed of available plastics, and the current lack of a standard reinforced plastic sheet for fabrication.

"A standard glass-reinforced plastic sheet such as I have predicted can be made. Perhaps the limiting factor now is your demand, as automotive engineers, for it. The fibrous glass component is available today; so are a variety of inert fillers. As for the plastic, there are one or two excellent candidates which can be brought into full production as rapidly as demand warrants."

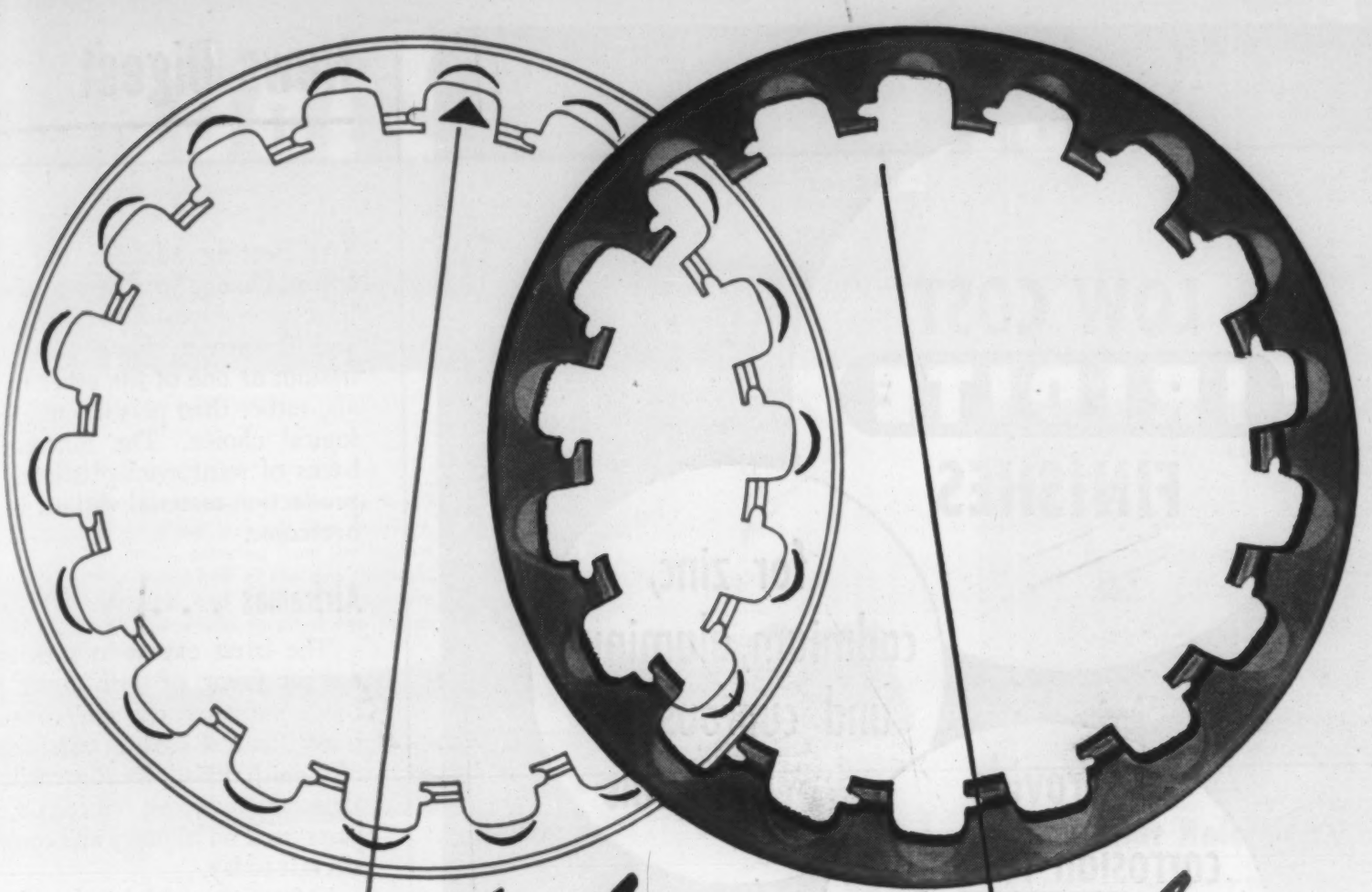
One of these materials is polydichloro-styrene, whose supply is currently limited almost completely to military requirements. Slayter said this resin, combined with chopped strand glass mat, and preheated to 450 F could be deep drawn in a press operating at 125 F with a press cycle of 15 sec.

Each Has Its Place

Slayter echoed the refrain of the responsible elements of the reinforced plastics industry who want their material to find its place on the basis of its inherent qualities, not just as a metal substitute: "There is no need for a competitive situation to develop between steel and the new nonmetal combinations, but rather there is an urgent need now for competent technical recognition of the most strategic uses of each system of properties."

The overall view of Mr. Slayter is generally optimistic. Probably the prevailing opinion in the automotive industry is more skeptical and can be summarized as follows:

The automobile industry is interested in reinforced plastics, as the attention devoted to them at this year's



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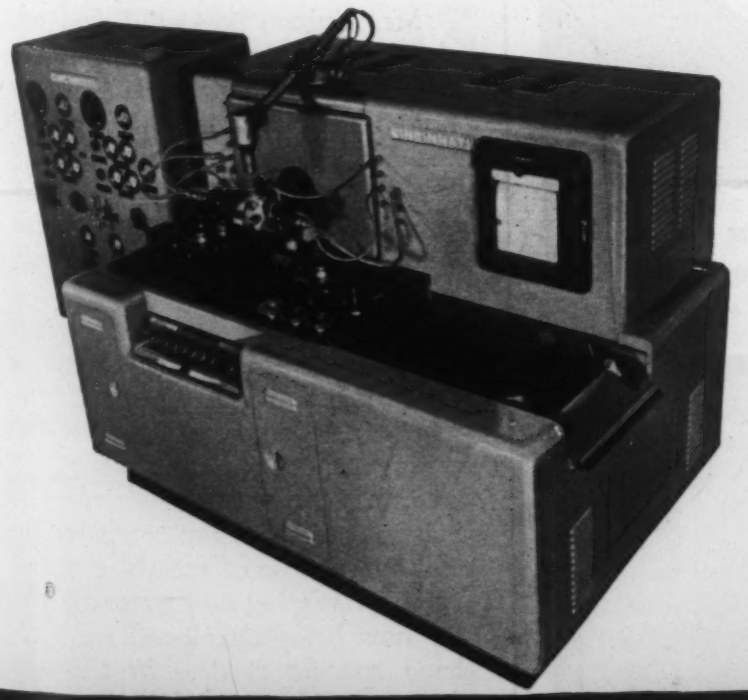

If ever there was one, here's a really tough heat treat job. The print called for all 18 internal lobes of this tank transmission cam (SAE 3145) to be hardened to Rc 53-60, body between lobes to remain ductile, pattern so consistent that inspection of only 1% of production would be permissible.

The nital etched section shown above (about half size) clearly shows the results achieved by Flamatic selective hardening. Production of 60 parts per hour was ten times faster than previous method. Scrap losses dropped practically to zero.

Gears, cams, rollers, parts with multiple diameters, etc., up to 18" OD depending on width or shafts up to 24" long depending on OD are readily handled on the Standard Flamatic. Write for Catalog No. M-1724 which includes case histories. Send part prints for analysis and recommendations.

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SAE meeting indicates. But any widespread change to a new material is at least several years away. And, when and if such a change occurs, magnesium or one of the other light metals, rather than plastics, might be the logical choice. The inherent drawbacks of reinforced plastics as a mass production material will not be lightly overcome.

Airframes . . .

The latest expert to stick his neck out in favor of reinforced plactics for complete airframe construction is William Braham, chief engineer of Zenith Plastics Co., which makes about 80% of the reinforced plastics parts used on military and commercial aircraft today.

"Materials used in aircraft can no longer be limited to metals," Mr. Braham told the annual meeting of the Reinforced Plastics Div. of SPI in February.

The reason, according to Braham, is that the strength properties of the light alloys fall off too rapidly at the sonic and supersonic temperatures encountered at speeds now being adopted for aircraft and missiles.

Plastics in aircraft is nothing new. But a complete airframe of plastics is something else again. Let it be said at the outset that Mr. Braham is no woolly-headed promoter. He has a competent background in aircraft design, in addition to a first-hand knowledge of the problems involved in adapting plastics to aircraft parts.

Glass-Phenolics

Mr. Braham presented data which showed that some glass-phenolic materials, on a strength-weight basis, can hold their own with other materials such as magnesium, aluminum, stainless steel and even titanium at room temperature, and move out ahead when temperatures get into the range between 250 and 500 F.

Strength is only one consideration, of course. Stiffness, too, is important, and it is the relatively low stiffness of plastics compared to metals that causes most of the skepticism about plastic airframes. Moduli of conventional glass-phenolics do not compare favorably with those of metals, even on a specific basis, but new materials which are now being developed are said to have specific moduli in the range from 3.50 to 4.25. Such values would compare favorably with, even surpass,

Tool Steel Topics

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

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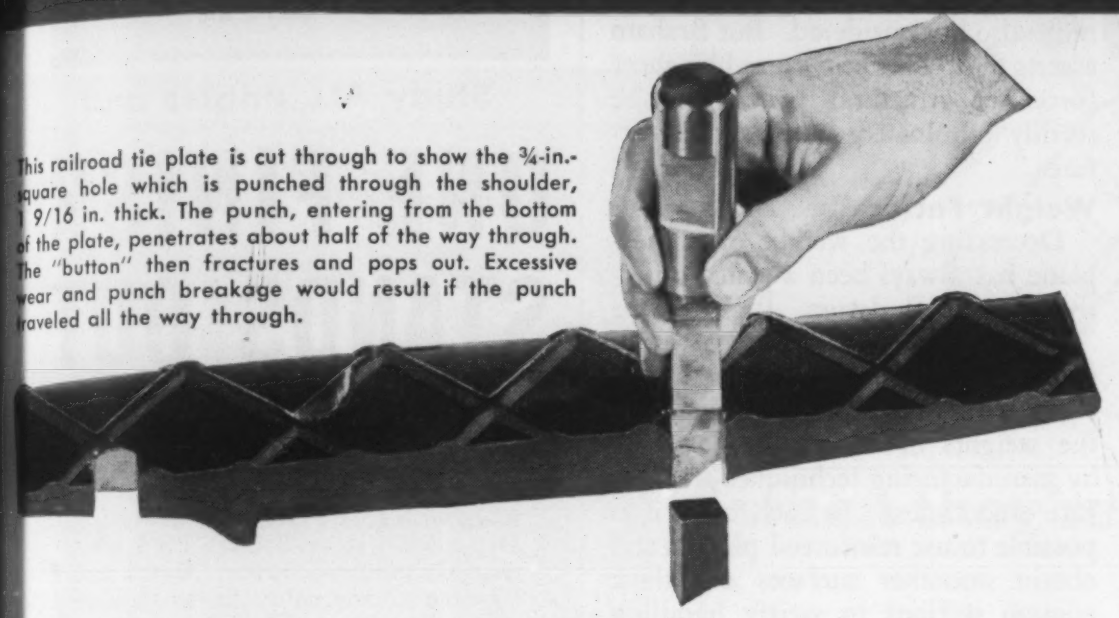


This railroad tie plate is cut through to show the ¾-in.-square hole which is punched through the shoulder, 1 9/16 in. thick. The punch, entering from the bottom of the plate, penetrates about half of the way through. The "button" then fractures and pops out. Excessive wear and punch breakage would result if the punch traveled all the way through.

Omega Adds 5 Lives To Rugged Punches

When a punch can average only 54 holes before failure, you would figure that the job is a tough one. And you would be right. Punching ¾-in.-square holes through 1 9/16-in. of tough steel in railroad tie plates is no job for an ordinary tool steel.

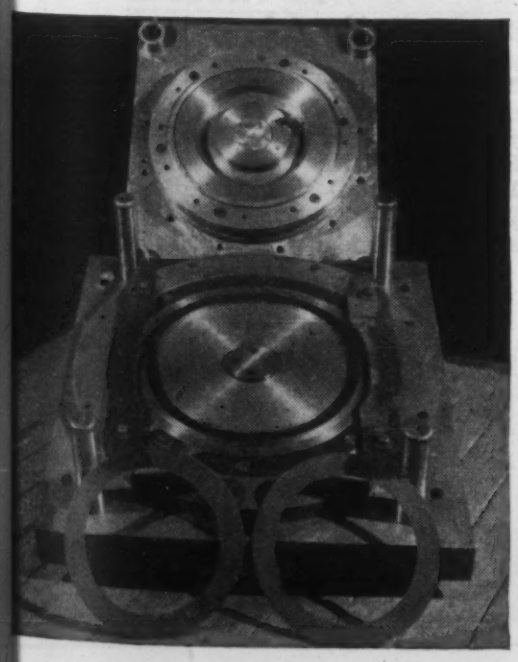
One of our metallurgical contact men studied this severe punching operation and recommended the use of our Omega tool steel. He pointed out to the shop men that it takes a shock-resisting tool steel — and a good one — to punch a hole that's smaller in diameter than the thickness of the steel. And in this case the steel plate is twice as thick as the width of the ¾-in.-square hole.

The first few punches made from Omega averaged well over 100 holes. So they made up 102 Omega punches and used them on a production basis. These produced 2 holes each in 18,160 plates — an average of 356 holes per punch, and more than 5 times the service life of the steel previously used.

This is another example of the way Omega can master heavy-shock applications. It's been doing a fine job for years on such tools as: pneumatic chisels, pawls, punches, knockout pins, swaging dies, shear blades, clutch and machine parts.

Omega is tops for cold-shock jobs. Your Bethlehem tool-steel distributor carries Omega in his stock for fast delivery.
Its typical analysis:

C	Mn	Si	Mo	Va
.60	.70	1.85	.45	.20



⬅ Blanking High-Carbon Sheets

The excellent shock-resisting properties of our 67 Chisel make it a good choice for the blanking of clutch-plate discs from .09-in., high-carbon sheet steel. Operating in a 350-ton press, this die produces about 30,000 pieces before any redressing is needed. The die is hardened to Rockwell C-53.

Despite its reputation for shock applications, 67 Chisel has plenty of wear-resistance for blanking tools, punches, swaging dies, hot-work tools, shear blades and master hobs. It's easy to carburize 67 Chisel whenever extra wear-resistance is needed . . . without sacrificing its tough core.

Stocked by Bethlehem tool steel distributors, 67 Chisel is easy to machine and heat-treat. Its typical analysis:

C	Si	Cr	W	V
.50	.75	1.25	2.50	.20

Dies That Hold Their Size

Being machined is a piece of Lehigh H for a progressive die that will blank, form and draw a precision part from 3/16-in. steel strip. When you machine a piece of our Lehigh H tool steel you can be sure that it's going to hold those accurate dimensions during heat-treatment. Distortion and warpage are held to the very minimum.

This high-carbon, high-chromium grade is also first choice for long wear and high compressive loads. And because Lehigh H is air-hardening there's little chance of quenching-cracks, even when dies have intricate designs.

Lehigh H is stocked in many sizes by Bethlehem tool steel distributors everywhere. Its typical analysis:

C	Cr	Mo	V
1.55	11.50	.80	.40

BETHLEHEM TOOL STEEL ENGINEER SAYS:

It's better to grind round tool steel bars than to cold-draw them.

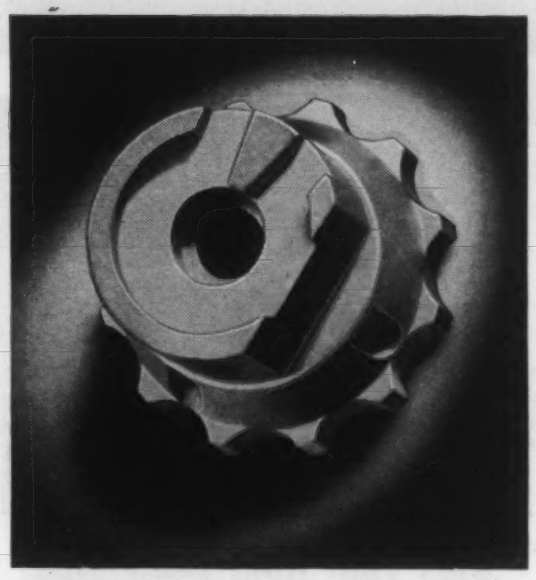
Because tool steel is inherently hard and brittle, it's ordinarily best not to specify that it be furnished in the cold-drawn condition. When very close size-tolerances are required, round bars are sometimes cold-drawn.

However, cold-drawing does *not* remove minor surface defects or decarburization. The surface of a cold-drawn bar must be machined off — just as with a hot-rolled bar — before tools are heat-treated. Otherwise, tools may crack in heat-treatment and will have a soft "skin."

It's better to finish round bars by centerless grinding, because the grinding does remove minor surface defects and decarburization. Tools can be made from ground bars without first machining off the surface.

Tool steel in sections other than round must usually be furnished cold-drawn if tolerances have to be close, because such sections as flats and squares cannot be surface-ground economically.

Just one example



stainless steel 18-8
weight ½ lb.

of how everyday, we are called upon to apply precision investment casting to solve difficult machining problems—such as the part illustrated above. All milling operations on this piece were eliminated by changing to investment casting.

FEATURES

- Alloy tool steels and any other metals may be cast.
- Economical to produce even in comparatively small quantities.
- Tolerances to general machine shop practice (plus or minus .005" on decimal dimensions and 1/64" on fractional).

Write for our newly prepared 8-page brochure that illustrates the variety of investment castings possible to produce, and processes involved—so you can judge their adaptability to your use in future production planning.

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STATE H'WAY No. 4 A
MORGANVILLE, NEW JERSEY

News Digest

equivalent values for the conventional metal alloys, which range from 3.25 to 3.75.

The lower shear modulus of plastics compared to conventional metals must also be considered. But Braham asserts that "buckling caused by sheer forces of structural panels can be readily eliminated in plastics structures."

Weight Factor

Decreasing the weight of an airplane has always been a prime objective in aircraft design. Braham says "there are many metal parts of existing aircraft and guided missile designs which are not heavily loaded, the weights of which are governed by manufacturing techniques and surface smoothness. In such cases it is possible to use reinforced plastics and obtain smoother surfaces and thick enough sections to satisfy handling requirements . . . Another factor favorable to plastics from a weight standpoint is the relative simplicity of producing light, bulky construction, through the utilization of sandwich cores made of foam or honeycomb."

But since thicker plastics sections would generally be needed to compensate for their lower strength and moduli, weight saving is not the primary advantage of plastics construction. Much more important, according to Braham, is lower fabrication costs.

It must first be understood that, by mass production standards, aircraft manufacturing is considered limited production. The large tapered metal plates now being used for frames involve high production costs as a result of the expensive machinery, the highly skilled machine operators and the great deal of time needed. Installation cost and scrap losses are also high.

Save on Space, Labor

Such tapered sections can be produced in plastics, on the other hand, with semi-skilled labor and with no expensive equipment other than molds for forming the structures.

Braham estimates that the construction of a single airframe of plastics would require about 20% of the floor space and labor required by metal fabrication. The same floor space could produce about two plastics fuselage sections per day, while metal fabrication would be limited to a maximum of one a week. Thus, the higher cost of materials in plastics construction would be easily offset by the lower

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CHROME COPPER

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ZINC is the cheapest metal to plate. Even with LUSTER-ON Passivating Dip added it still COSTS LESS than Cadmium, Copper, Nickel and Chrome or any other finish that we know of today.

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Zinc plate with simple Luster-on cold dip treatment will usually SAVE 2/3 of the PROCESSING TIME of flash copper, nickel and chrome work. TIME COSTS YOU MONEY – SAVE IT WITH LUSTER-ON.

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Zinc plate and Luster-on require no heavy power to plate or heat metals such as nickel and chrome. YOU SAVE ON POWER USED and RECTIFIER or GENERATOR EQUIPMENT REQUIRED.

Study THE FINISH

Zinc and Luster-on, applied manually or in full automatics, can nowadays show finishes so beautiful, so gleaming that they bow to no one. Proved again and again superior to cadmium for most purposes, they rival traditional chrome.

Study ALL ANGLES

You'll soon see why big companies and job shops alike agree that Zinc and Luster-on is here to stay – has established itself over the years, not just as a substitute for scarce metals. BUT BE SURE THE PASSIVATING DIP YOU USE IS GENUINE Luster-on – "The first in the field and still the leader."

Write for free data sheets and send a part for free processing.

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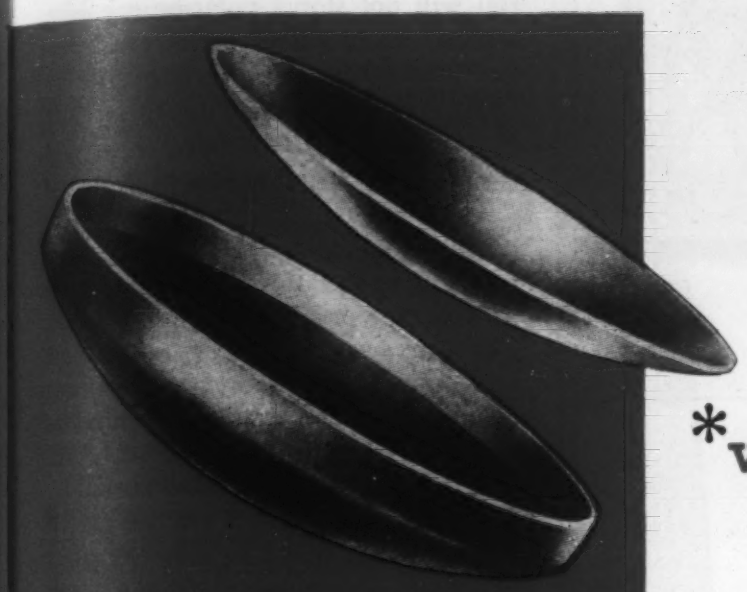
heads---you win *

*when they're made by

CLAYMONT



Flanged and Dished Heads

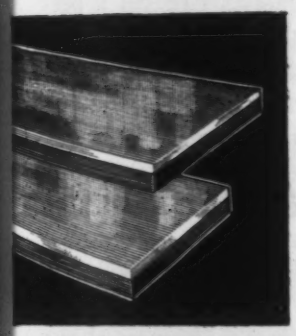
Whatever your needs in flanged and dished heads, you're a winner every time when you call for heads by Claymont.

We can always meet your most exacting specifications because with us the spinning of flanged and dished heads is more than just a job—it's an art into which we put the most painstaking care and specialized know-how.

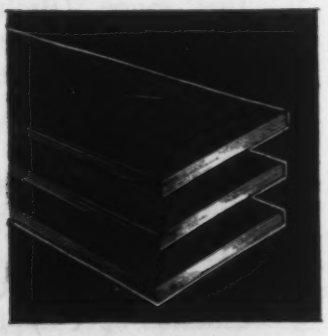
Our flanging department can supply you with flanged and dished heads in diameters from 9 inches to 19 feet and in gauges from 3/16-inch to 6 inches. Made in carbon steel, alloy steel or with stainless steel cladding. We are also prepared to handle head forming operations on both ferrous and non-ferrous metal circles supplied by the customer.

Other Claymont products include Stainless-Clad Steel Plates, Alloy and Carbon Steel Plates, Large Diameter Welded Steel Pipe.

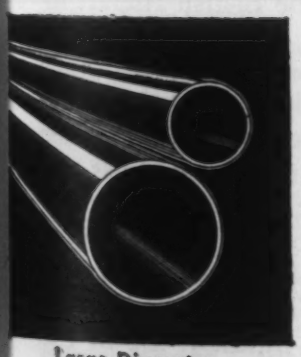
Write or call Claymont Steel Products Department, Wickwire Spencer Steel Division, Claymont, Delaware.



Stainless-Clad Steel Plates



Alloy and Carbon Steel Plates



Large Diameter Welded Steel Pipe

THE COLORADO FUEL AND IRON CORPORATION—Denver, Colorado
THE CALIFORNIA WIRE CLOTH CORPORATION—Oakland, California
WICKWIRE SPENCER STEEL DIVISION—Atlanta • Boston • Buffalo
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CLAYMONT STEEL PRODUCTS

PRODUCTS OF WICKWIRE SPENCER STEEL DIVISION
THE COLORADO FUEL AND IRON CORPORATION

CF&I

News Digest

labor and overhead costs.

There are, of course, many technical characteristics of reinforced plastics which make them interesting for airframes. For instance, the material will not stop a radar beam; thus, a plane made almost entirely of plastics would be almost undetectable by radar. Radomes in military aircraft make use of this property.

Corrosion Resistance

In addition, reinforced plastics possess good corrosion resistance and, in most applications, would require no coatings or paint to protect them. They are susceptible to rain and dust erosion at high speeds, but Neoprene or sprayed metal coatings applied to the surfaces most subject to such erosion give satisfactory protection.

Versatile as plastics are, no one is claiming that they can take the place of metals, ceramics and metal-ceramic materials when it comes to temperatures near and above 1000 F. This has led some designers to ask, in effect: Even if plastics can do a better job in a certain temperature range, why bother with them when the future will require materials for much higher temperatures anyway?

The best answer to this question is the probability that a great number of aircraft will be built to operate at speeds where the skin temperature is in the 250 to 600 F range before very many will be built to operate above that range. Braham contends: we have the material now—why wait for a better one when there is such a wide range of operation for which plastics are suitable?

British Progress

Mr. Braham also has a warning. Referring to the expanding use of "Durestos", a material composed of asbestos fiber impregnated with phenolic resins, in the British aircraft industry, he said:

"The British today are setting a pace in the development and application of plastics to aircraft and guided missle primary structures that has outdistanced our industries and armed forces. Many experts familiar with American know-how, resources, aircraft design requirements, and our reinforced plastics industry, are of the firm conviction that we can quickly reach the pace set by the forward-thinking British, if we realize the advantages and properties of our materials and utilize them wisely."

(*More News Digest on page 205*)

Facts about *HELI-COIL* inserts you should know

What they are

*Heli-Coil** screw thread inserts are precision formed coils of stainless steel or phosphor bronze wire. Wound into tapped holes, they form permanent, non-corrosive, strip-proof threads of astonishing strength. Available for National Coarse, National Fine and Unified threads, pipe threads and spark plug threads. They are made in all standard sizes and lengths for assemblies requiring Class 3, 3B, 2 or 2B fits.

What they are for

AS ORIGINAL COMPONENTS: *Heli-Coil* inserts are used to provide stronger, lighter fastenings, corrosion-proof, wear-proof threads in all assemblies.

FOR PRODUCTION SALVAGE: When conventional tapped holes are damaged in production, restore them on the line with *Heli-Coil* inserts. Get better-than-original strength with no increase in screw size and no tell-tale signs of rework.

FOR SPEEDY REPAIRS: When tapped threads wear, strip or corrode in service, renew them in minutes on location in shop or field with *Heli-Coil* inserts. No welding—no plugging—no secondary machining—no oversize screws.

How they work

Holes are drilled and tapped as you do for ordinary threads—then *Heli-Coil* inserts are wound into tapped holes by hand or power tools. Install in a few seconds, assure thread protection forever. Can be used in any metal wood or plastic.

No other method is so simple, effective and practical.

What they do for you

Heli-Coil inserts *save money* because they strengthen threads and make *fewer* smaller fastenings do the same holding job. They make *lighter* bosses and flanges practical and they *save weight* in two ways: (1) by permitting use of cap screws, instead of bolts and nuts; (2) by allowing use of smaller, shorter, fewer cap screws. *Heli-Coil* inserts *protect* your product from thread wear, galling and stripping for life in every kind of metal, in plastics or wood. They preserve customer good-will by preventing product failure, due to thread fault. *Heli-Coil* inserts improve the end product, cut rejects, salvage threading errors.

Best time to put *Heli-Coil* inserts benefits to your use is right at the designing board, as many leading manufacturers are doing. But to convince you of their many advantages ask for a working demonstration right on your production line. Write today! Complete information and engineering data is available in the *Heli-Coil* catalog. Use Coupon!

*Reg. U. S. Pat. Off.

Approved for All Military and Industrial Uses

7 savings wrapped up in HELI-COIL inserts

These savings are multiplied into major profits this simple way

Use *Heli-Coil** Inserts to:

1. *Save* money by using fewer and smaller screws to do the same holding job.
2. *Save* material—lighter bosses, thinner wall section, smaller flanges.
3. *Save* weight and reduce bulk in assemblies.
4. *Save* assembly time by using cap screws instead of nut-and-bolt assemblies.
5. *Save* rejections in production. Threads damaged on the line are quickly repaired. You save time. Reduce scrap.
6. *Save* on field service costs. No field damage to threads—fortified by *Heli-Coil* inserts.
7. *Save* customer good will by eliminating product failure due to thread fault. Every thread in your product is made stronger, longer wearing with *Heli-Coil* insert protection.

Use the handy coupon to get *free sample Heli-Coil* inserts plus all the data you need to design these savings into your product.

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☐ Send samples and Handbook 652, a complete design manual.

☐ Send samples and put my name on list to receive "*Heli-Call*," case history periodical.

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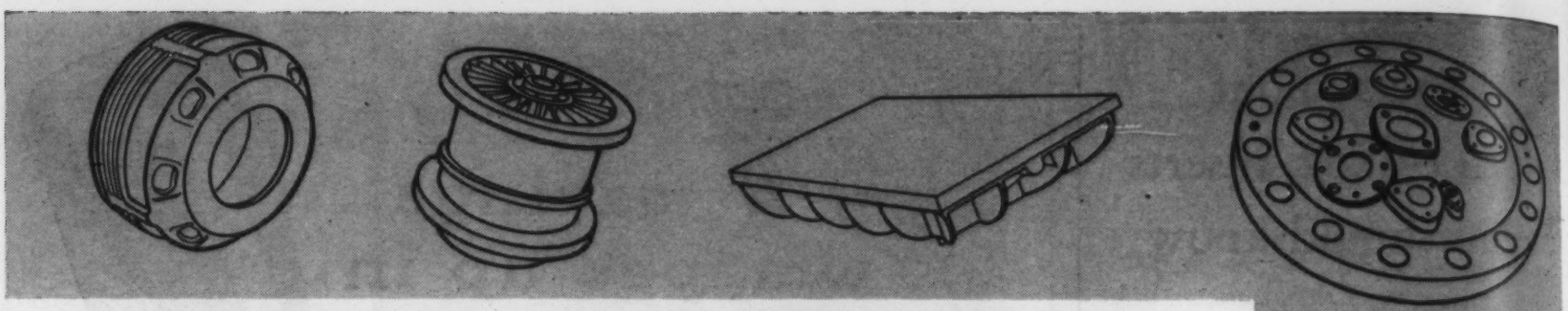
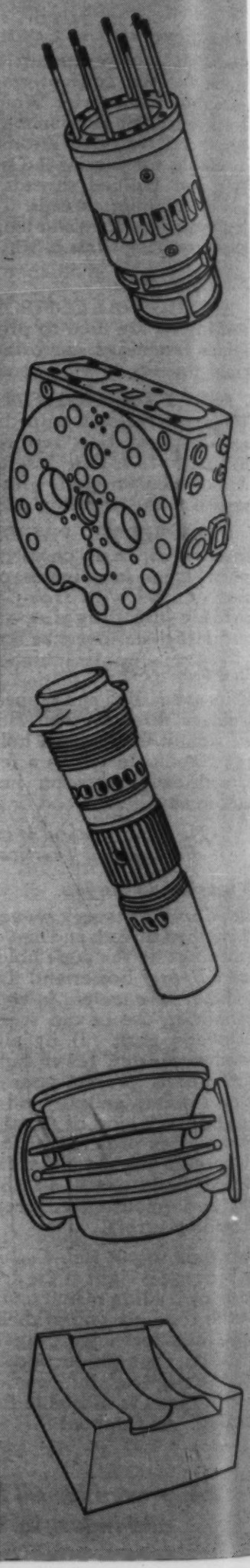


HUNT · SPILLER **GUN IRON**

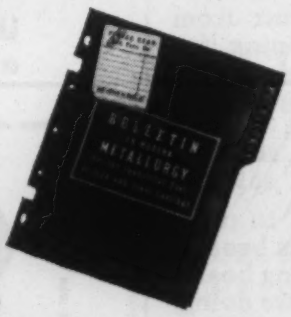


Makes a Big Difference in CASTINGS

Four small letters on cast iron parts spell a lot today. They are your assurance that the casting is made of a super-refined iron, highly resistant to frictional wear, high heat, pressure and erosion. Because of these exceptional advantages—Hunt-Spiller Gun Iron is recognized as offering the finest material for casting requirements.

With Hunt-Spiller Gun Iron you receive:

- **25% more strength than cupola grey iron**
- **A resistance to heat up to 850-900 degrees Fahrenheit**
- **Increased density and higher level of hardness**
- **Uniform metal structure assuring excellent machine characteristics**
- **Close pearlitic grain for smooth machined surfaces in both deep and finish cuts**
- **Rapid and positive response to heat treatment**



Write today for detailed information of Hunt-Spiller Gun Iron and of its multiple uses throughout industry. It will pay you to investigate Hunt-Spiller Gun Iron.

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News Digest

Brazing Filler Metal "Specs"

Specifications for brazing filler metals have been established by the American Society for Testing Materials and the American Welding Society. The new specifications cover every type of brazing filler metal in common use today. Heretofore, only a few specific materials have been covered.

The 33 different classifications are divided into groups according to the principal constituents. Included are aluminum-silicon, copper-phosphorus, silver, copper-gold, copper and copper-zinc, magnesium and heat resisting filler metals.

As usual, the specifications include an appendix designed to assist in the selection of the alloy best suited for a given application. Information is given on the brazing temperature range for each classification, color of the joint obtained, recommended joint designs, and fundamental concepts of brazing often misunderstood.

Copies of the specifications can be obtained at 40¢ each from either the AWS, 33 W. 39th St., New York 18, or the ASTM, 1916 Race St., Philadelphia 3.

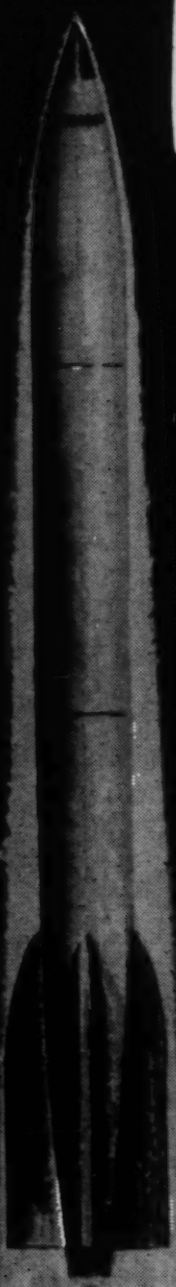
Complex Steel Parts Available as Hot Extrusion Takes Hold

A little more than four years ago, the first successful hot extrusion process for steel went into operation in Persan, France.

Less than a year later, a representative of CIE, a subsidiary of the Societe d'Electro-Chimie, d'Electro-Metallurgie et des Acieries Electriques d'Ugine, landed in New York City carrying details of the new process. Shortly thereafter, in March 1950, the first technical article on the new process and its implications to be published in this country appeared in this magazine.

Today, four large U. S. companies are using the French process, named Ugine-Sejournet in honor of its inventor. International Nickel was first licensee of the process, which has been in operation about two years in its Huntington, W. Va., plant. Next

New ChemoTec bonding agents

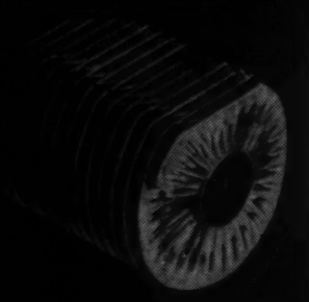


join metal to metal... or metal to non-metals... without heat... without pressure... at low cost!

Now, with these amazing new organic bonding agents, you can join similar metals . . . or dissimilar metals . . . or metals to non-metals . . . quickly, easily—at extremely low heat or no heat at all!

What's more, simple contact-pressure is enough to form a *permanent, porosity-free* bond with tensile strengths exceeding those of many solders! Now you can design and produce — AT LOW COST — such previously "impossible" combinations as:

TITANIUM TO MAGNESIUM TO ALUMINUM • METAL TO GLASS TO CERAMICS • STEEL TO RUBBER TO BRASS • WOOD TO LEATHER TO COPPER — *and scores more!*



The bonding of "fin-tubes" on heat transfer equipment such as this has up to now presented an almost insurmountable metal-joining problem. Today, the extraordinary thin-flowing characteristics of ChemoTec permit it to penetrate to the desired areas by capillary action. Thus, swift and efficient bonding is obtained .. with excellent color match . . . with tensile strength that more than meets specifications . . . at substantial savings in time, labor, and materials!

Tensile strengths exceeding 5000 psi. • Low labor costs • Excellent capillary action • Free flowing Low cost • Heat not essential • No annealing of base metal • Perfect heat control • No galvanic action • No porosity • Pressure not essential Perfect insulation • No corrosion • No flux needed Economical in mass production

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ChemoTec Bonding Agents are available in liquid, paste, powder or rod form to answer every production need. Send for FREE illustrated literature, technical data, etc., to see how these new developments can help solve YOUR joining headaches ... today!

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These new ChemoTec Bonding Agents sound interesting. Without cost or obligation, send me FREE illustrated literature and further information about how they can be adapted to my specific production needs.

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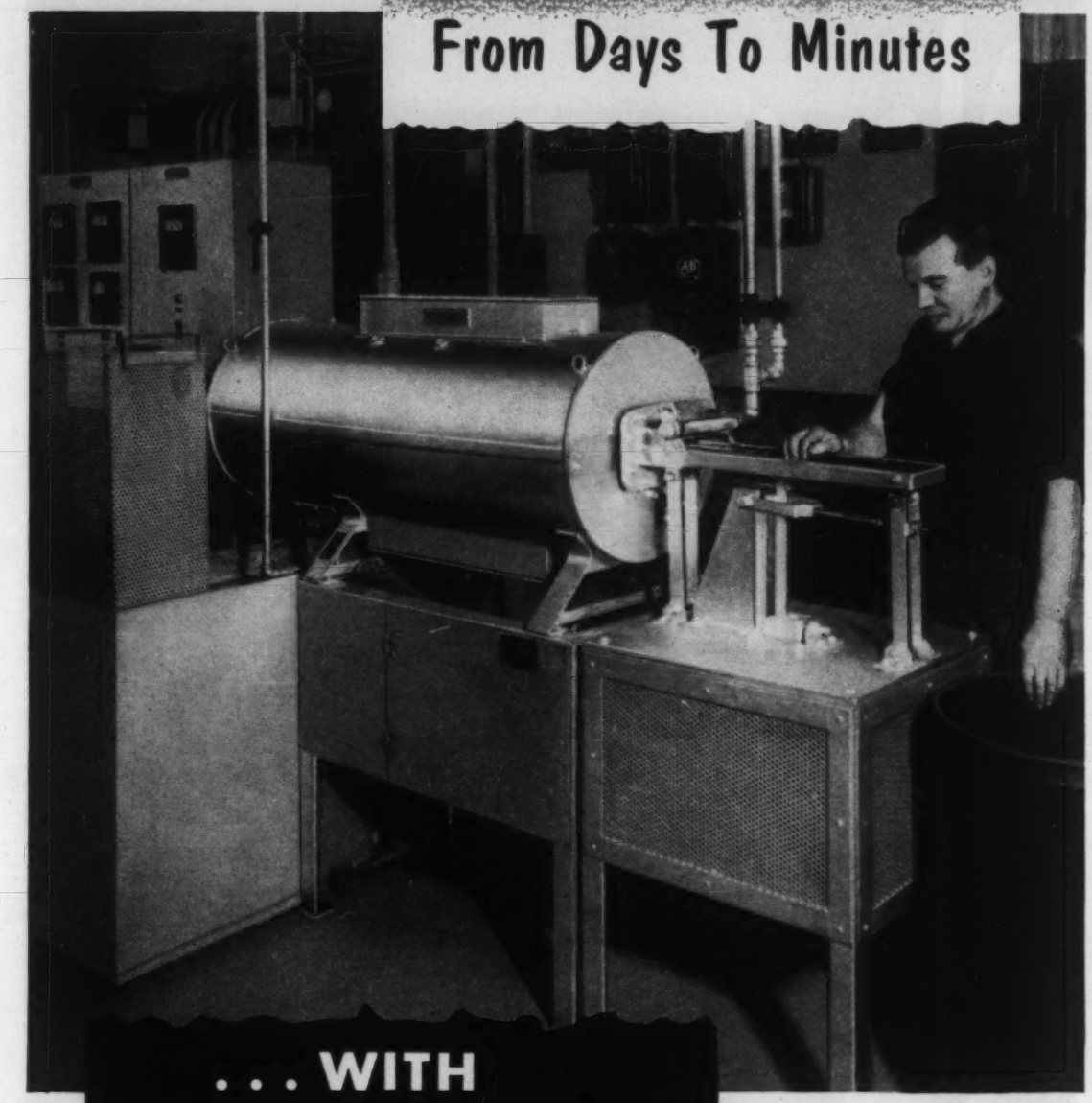
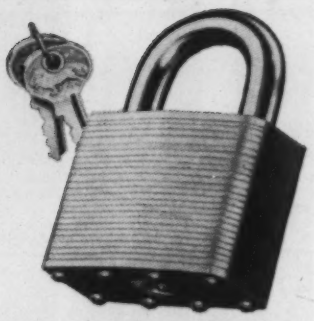
Hardening Time Cut
From Days To Minutes



. . . WITH
HEVI DUTY
SHAKER HEARTH
FURNACE



Master Lock Company

SPEEDS PRODUCTION WITH THIS NEW FURNACE

Heat treating of an 80 pound batch of small springs required two days when hardening in charcoal filled containers. This process was not only slow but also costly due to a high percentage of rejects.

Now in a Hevi Duty Shaker Hearth Furnace, a similar batch is "bright" hardened in 75 minutes. Each spring receives uniform heat treatment without distortion thus cutting production costs. This furnace has been designed to solve your problem of heat treating small parts.

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Learn more about this modern production tool and the way it can help you.
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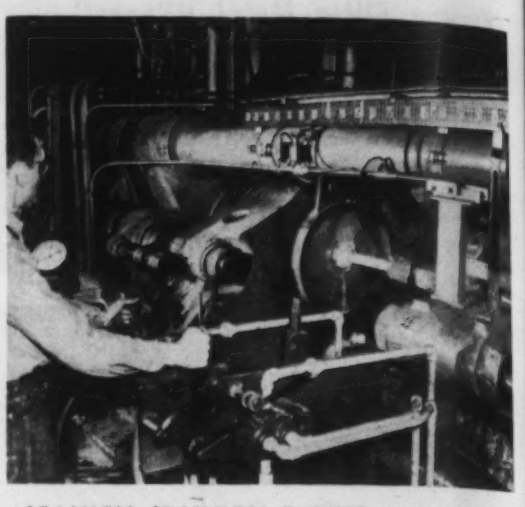
HEVI DUTY ELECTRIC COMPANY
MILWAUKEE 1, WISCONSIN
Heat Treating Furnaces . . . Electric Exclusively
Dry Type Transformers *Constant Current Regulators*

News Digest



***SEAMLESS STAINLESS TUBING** and complex high-alloy shapes that defy rolling are being produced in this country by the French Ugine-Sejournet hot extrusion process for steel. Shown here is the 2500-ton hydraulic press in operation at the Gary Plant of U. S. Steel's National Tube Div. Three other U. S. Steel companies are using this process, with more to follow.*

were Babcock and Wilcox and Allegheny-Ludlum, with the National Tube Div. of U. S. Steel the latest user. Jones & Laughlin is expected to be in operation before too long, and others are already slated to follow.

The most important results of the increasing adoption of the French process in this country are these:

1. It makes available certain complex shapes in high-alloy steels and high temperature alloys that cannot be rolled because of their unbalanced design. Without a practical extrusion process, such shapes would require extensive machining and, therefore, have not been feasible up to now.

2. Some shapes in ferrous and high-temperature materials which *have* been available can now be bought as extrusions at much lower cost.

3. In addition, all other technical and economic advantages commonly associated with extrusions are now extended to steels and high temperature alloys. Among them are high mechanical properties due to three-dimensional working of the metal; less waste of metal; and great tooling flexibility which makes possible rapid filling of orders.

A good example of a shape which formerly had to be rolled and welded but can now be extruded is stainless steel tubing. The press at National Tube's Gary Plant, for instance, is

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REDUCES WEAR, ABRASION, CORROSION OF PARTS . . . GIVES 200% TO 800% LONGER LIFE

If your problem is wear, abrasion or corrosion of metal parts, quite likely Electrolizing can provide the solution.

A tested and proven surface treatment used by many major companies since 1945, Electrolizing is increasing the life of such parts as hydraulic pistons, shafts, valves, impellers, rotors, blades, screw jacks, spindles from 200% to 800%.

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Electrolizing is specified for 38 jet aircraft parts. Laboratory and field tests definitely established the desirability of *Electrolizing* pistons, valves, shafts, bushings, arms and similar parts which were subjected to severe wear, abrasion and corrosion.

Our staff engineers are available for consultation without obligation. Write for new booklet describing *Electrolizing* and its advantages.

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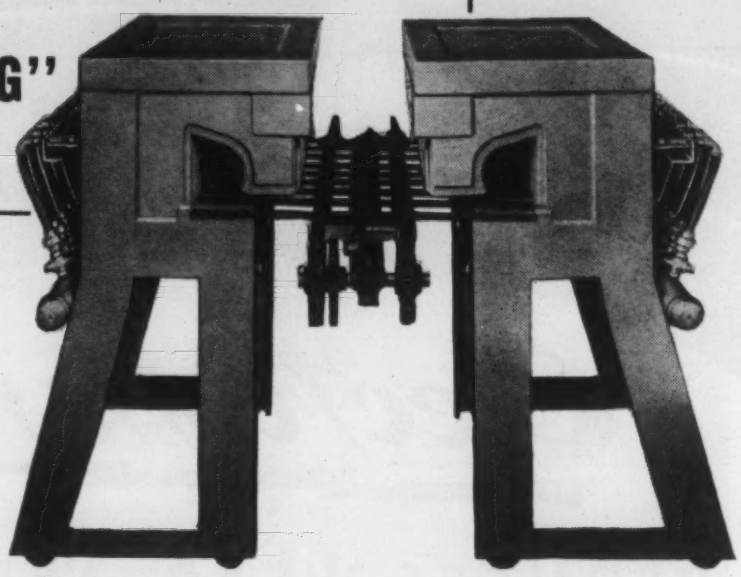
Twin ROTO-FLAME FURNACES QUADRUPLE "END HEATING" PRODUCTION



Exclusive (High-Speed) Roto-Flame Design Cuts Heating Time in Half

The above installation shows how a leading automotive spring maker revolutionized spring leaf production in his plant by using 2 units . . . thus heating both ends of flat bar stock simultaneously before swaging (or eye-curling) operation.

Boosts Production—through much faster heating . . . uniform control . . . uniform temperature.
Cuts Operating Costs—Operation can be made fully automatic . . . saves fuel . . . saves labor . . . saves 75% floor space . . . prolongs die life.
Provides Better Working Conditions—Heat concentrated on work . . . not on operator. Utilizes any type of gas fuel.
New Savings in Heating—for forging, swaging, upsetting, threading, hardening, or annealing. Ask for Bulletin No. 350.

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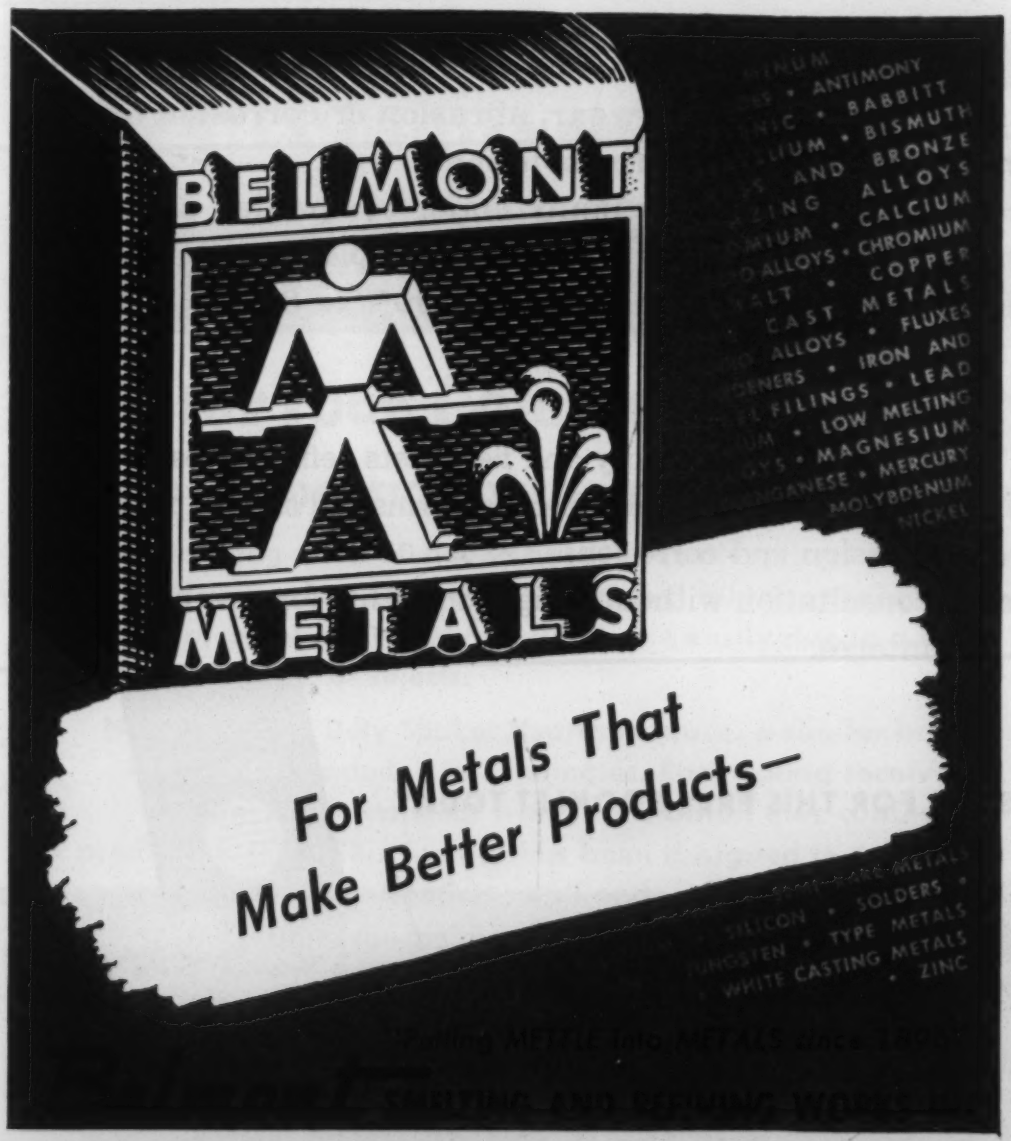

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ALL METALS • ALL ALLOYS • ALL FORMS

News Digest

capable of producing seamless tubing from 1½ to 6¼ in. o.d. At full production and with favorable product mix, it is estimated that the 2500-ton press will turn out more than 2000 tons a month. In terms of steel mill tonnages, this is a relatively small operation, but expansion can be expected after a reasonable trial period.

Key to the French extrusion process is the use of glass as a lubricant. Glass goes into the press ahead of the slug to be extruded; the slug itself is wrapped in glass fiber; and the mandrel is covered by glass fiber. Under the heat and pressure employed for ferrous alloys, the glass melts and lubricates all surfaces. Conventional lubricants, of course, would vaporize and lose their effectiveness.

It seems quite likely that the hydraulic extrusion press will become a standard tool of the steel plant, and that the increased flexibility in materials selection and design which it makes possible will become a standard engineering tool.

Hardboard Output Facilities Undergoing Broad Expansion

A significant revolution now underway in the wood industry holds promise of more broad usage of wood-based materials in the future. A sudden awakening to the possibilities of hardboard has led to an unusally rapid expansion of facilities for the production of this material.

In 1948 there were just three plants producing hardboard in this country, and the daily capacity was 935 tons, or 2,500,000 sq ft of ⅛-in. board. Major producer was Masonite Corp. (more than 85%) which pioneered hardboard in this country, followed by U. S. Gypsum Co. and Chapman Manufacturing Co.

Capacity Rising

By the end of this year, it is expected that 16 plants will be in operation or nearly ready to start operations. Daily capacity will be 2,075 tons, or 5,700,000 sq ft of ⅛-in. board, an increase of 130% in five years.

The new capacity includes a 200-ton

Around the Clock PRODUCTION AGAIN WITH SPENCER TURBOS

"In 1942 we moved to our present location and at that time we purchased 2 Spencer Turbine Blowers; these operated 24 hours a day, 7 days a week, until August 1945 and from then until now have operated from 4:30 in the morning 'til 6 o'clock some nights and many nights around the clock. They are both operating at the present time and have never been touched except for oiling. These blowers have been more than satisfactory for continuous operation."

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BENNETT STEEL TREATING CO.
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That's one reason why more than 30 manufacturers of furnaces and ovens prefer Spencer and why the horse-power installed has increased tenfold in ten years.

Other reasons include quiet operation, without vibration—no special foundations, a wide range of standard sizes and special power drives for any location. Your next Turbo is described in Bulletin No. 126-A. Application data in Bulletin No. 107-C.

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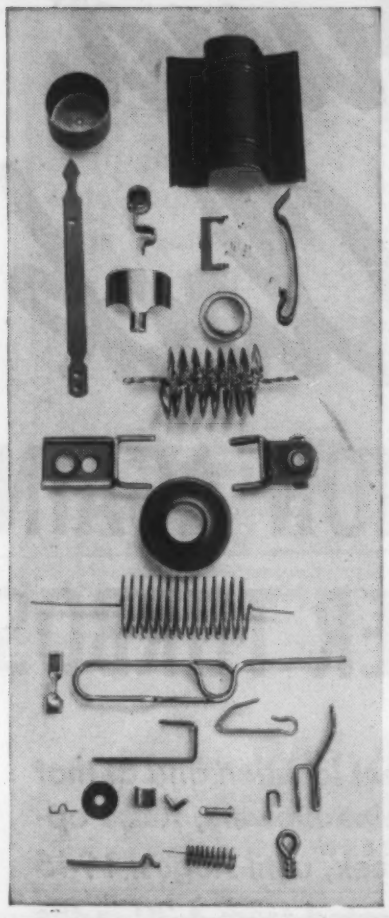

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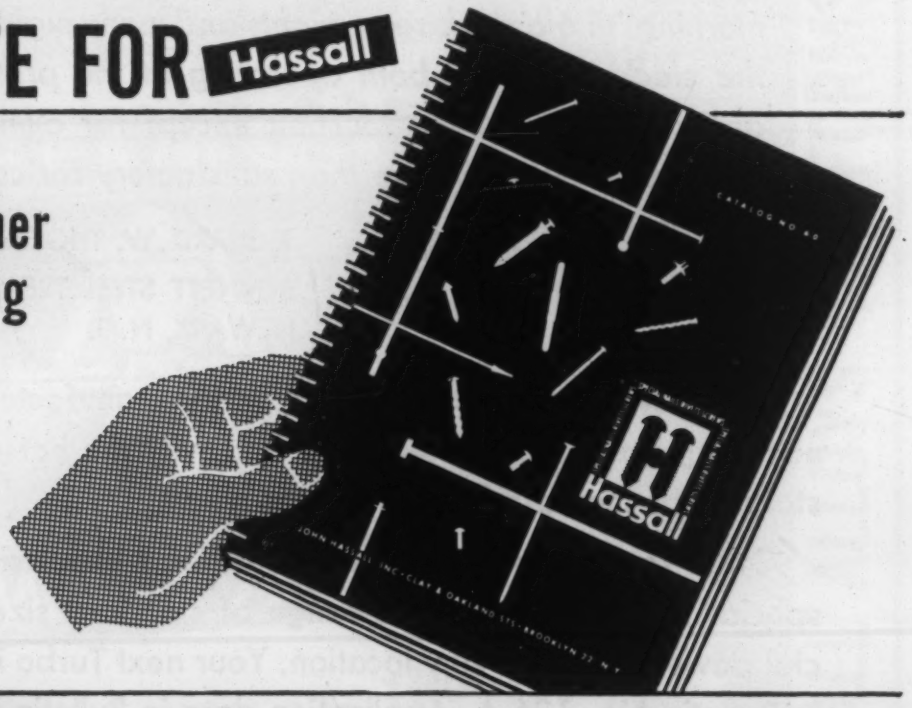

A complete, comprehensive handbook on cold-headed nails, rivets, screws and other special fasteners. Check on ways to improve your assembly cost-wise, appearance-wise and from a standpoint of maximum effectiveness at minimum cost. One hundred years of experience are at your service. Write for price quotations or for suggestions on the redesigning of your present assembly.

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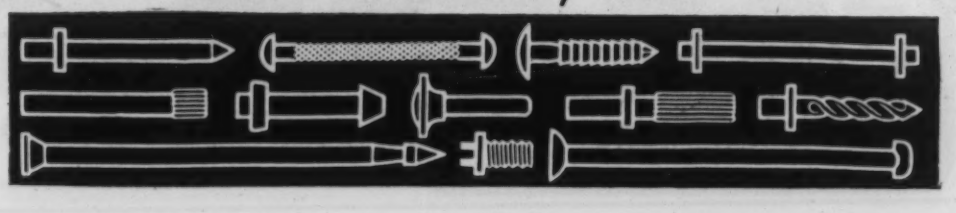


News Digest

increase by Masonite Corp., which will still be the major factor in the field with 48% of total capacity. New companies in the field (in order of initial capacity) include: Coos Bay Lumber Co.; Pack River Lumber Co.; Forest Fiber Products Co.; Oregon Lumber Co.; Cascade Plywood Corp.; Anacortes Veneer, Inc.; Weyerhaeuser Timber Co.; Oregon Fiber Products Inc.; Longbell Lumber Co.; Rock Island Millwork Co.; Superior Wood Products, Inc.; and Curtis Companies, Inc.

How It Is Made

Hardboard is a fiberboard composed of vegetable fiber and natural and added binders, formed in a mat and pressed in the presence of heat so that the resulting product is essentially a homogeneous sheet having a specific gravity of at least 0.8. As such, hardboard falls into a higher density classification than the so-called "intermediate density" board, and the still lighter rigid insulation board and semi-rigid insulation board.

The term hardboard is currently applied to the material made either by wet or dry "felting" of fibrous wood or by resin bonding of sawdust planer shavings and other particles of millwork waste. The latter are a small part of current production but appear to be gaining considerable interest.

Moldings a Possibility

Although hardboard is identified as a sheet material, some men in the industry think the real future of hardboard lies in molded shapes. If the sheet material market fails to materialize to the extent now envisioned, it is not unlikely that some segments of the industry will turn their attention to the possibilities of moldings.

Currently, hardboard has many of the same uses as the thinner thicknesses of plywood, except where weight is of paramount importance, as in packaging.

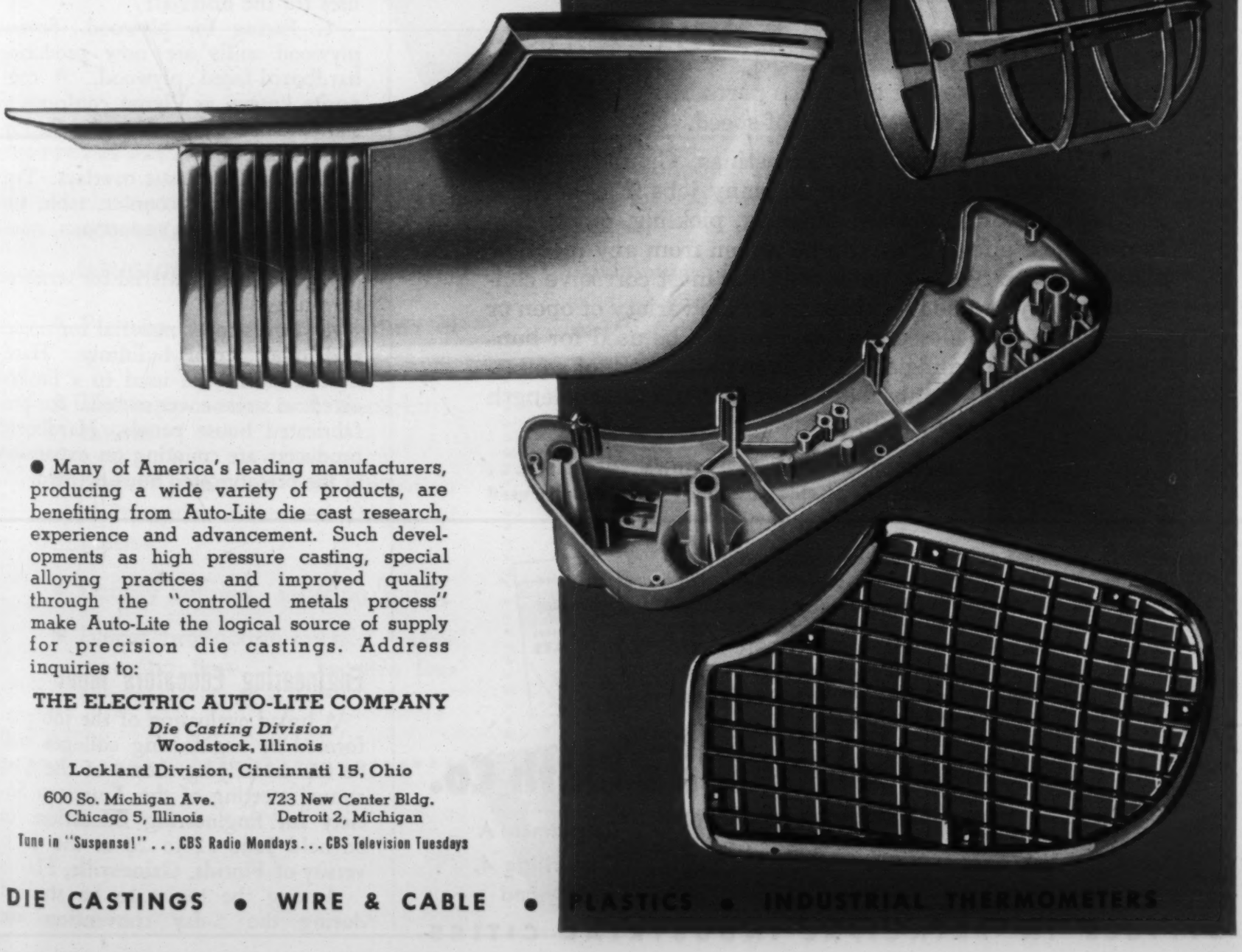
In many applications, hardboard has demonstrated important service advantages over competing materials. Some of these applications are:

Present Uses

1. In the furniture industry, for mirror backs, drawer bottoms, desk tops and insert panels for chests of drawers and wardrobes.

2. In appliances, for backs for radios and television sets and as

You're always right with AUTO-LITE Die Castings



● Many of America's leading manufacturers, producing a wide variety of products, are benefiting from Auto-Lite die cast research, experience and advancement. Such developments as high pressure casting, special alloying practices and improved quality through the "controlled metals process" make Auto-Lite the logical source of supply for precision die castings. Address inquiries to:

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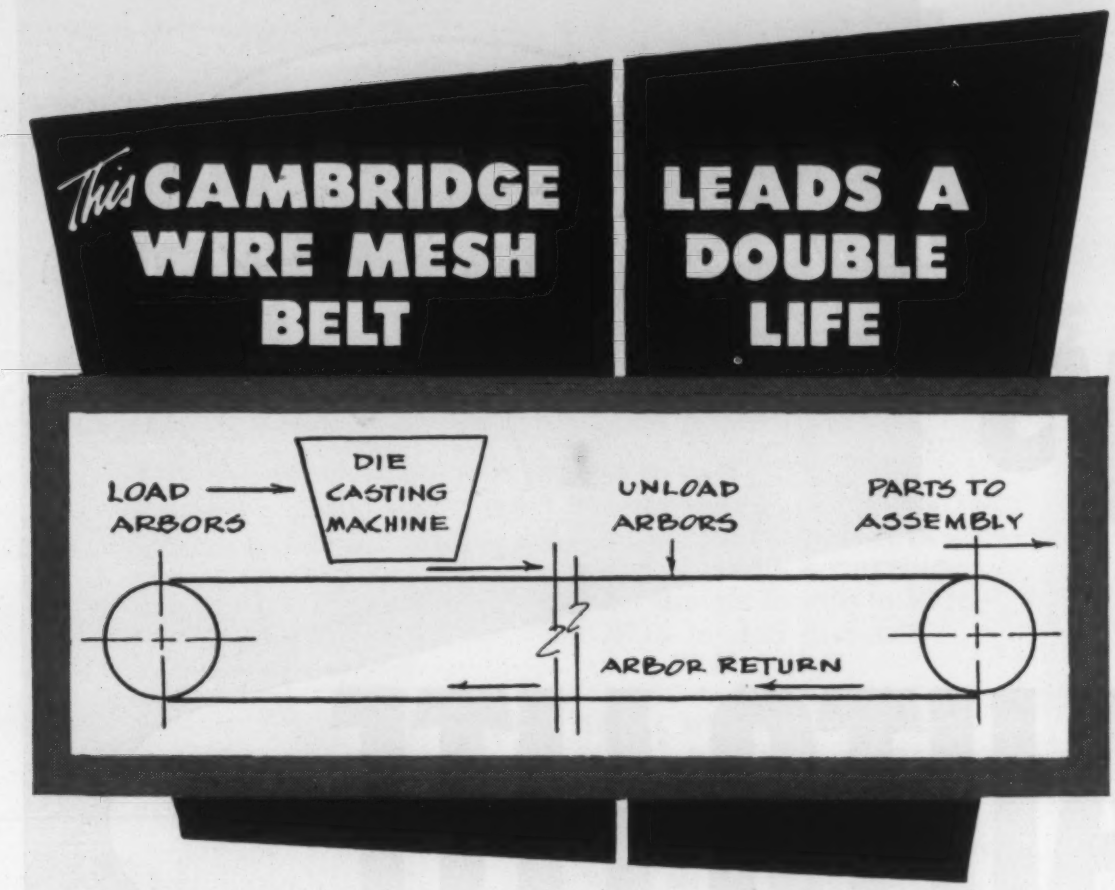
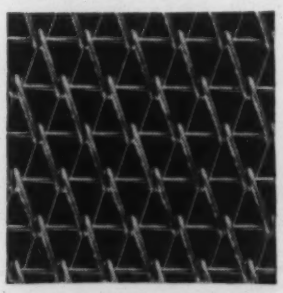


Here's a customer who gets double use from his Cambridge wire mesh conveyor belt. He uses the top side of the belt to carry loaded arbors from the diecasting machine . . . *uses the bottom side to carry empty arbors back to the machine for re-use.* Savings in equipment! Savings in floor space! Savings in handling and time!

Room air circulates freely through the open mesh of the belt to cool the castings. Hot castings cannot harm the all-metal belt. The moving belt feeds parts to the subsequent assembly line at a constant rate of speed.

Even if you're not making diecastings, Cambridge wire mesh conveyor belts can help do many jobs in your plant . . . heat treating, brazing, sintering, pickling, quenching, to name just a few, They can be woven from any metal or alloy, thus can be used under even the most corrosive conditions. They can be fabricated in a wide variety of open or closed meshes, thus can be used for handling small or large parts. And, of course, Cambridge belts are made to any length or width.



HERE'S A TYPICAL CAMBRIDGE SPECIMEN . . . Rod-Reinforced. This particular weave is widely used in continuous heat treating furnaces.

For complete information on how Cambridge wire mesh belts can help you combine movement with processing, call in your Cambridge Field Engineer. He's listed under "Belting-Mechanical" in your classified telephone book. Or, write direct for this NEW, WIRE MESH BELT CATALOG. IT'S FREE! Gives conveyor and conveyor belt design and installation data, metallurgical tables, other useful information.

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News Digest

liners and backs for refrigerators and freezers.

3. In manufacturing operations for templets and jigs. Some of the denser varieties are used to a limited extent in dies and forms for working metals and for electrical control panels.

4. In household furnishings, for facings for flush doors, and as backs, doors and counter tops for kitchen cabinets and storage units.

5. In transportation, for panels, liners and partitions in truck, bus, trailer and Pullman car bodies.

6. In buildings and houses, for paneling, counter faces and tops, facing for concrete forms, linoleum underlayment, exterior wall covering and, to a limited extent, as floor surfacing.

7. In advertising displays, signs and toys.

New Uses

Much of the optimism in the hardboard field at present is based upon four relatively new projected uses for the material:

1. Facing for plywood. Several plywood mills are now producing hardboard-faced plywood. A composite known as Plyron conforms to standards set by the Douglas Fir Plywood Assn.

2. Base for plastic overlays. Typical applications: counter, table and bar tops in homes, restaurants, stores and taverns.

3. Crossband material for veneered furniture.

4. Stress-cover material for homes and other small buildings. Hardboards have been used to a limited extent as stress-cover material for prefabricated house panels. Hardboard producers are counting on expansion in the prefabricated housing field.

Engineering Educators Meet

A broad evaluation of the job performed by engineering colleges will be the underlying theme of the 61st annual meeting of the American Society for Engineering Education, to be held June 22 to 26 at the University of Florida, Gainesville, Fla.

Among the topics to be studied during the 5-day convention are

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- Lower production costs . . . save cleaning time . . . require less expensive equipment.

● In Houghton's complete line of heat treating salts, you'll find the most advanced agents available for heat treating metals.

Aluminum parts, for example, are safely and efficiently treated with DRAW-TEMP 430. The salt meets requirements of MIL-S-10699, Class 2. It has a melting point of 430° F.—a working range of 550° to 1000° F. It treats aluminum in one-third less time than in atmosphere furnaces. And its thin film protects the metal enroute to the quench.

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Virtually all the brass mills in North America use the Ajax-Wyatt induction melting furnace, for it has the lowest metal losses in the field—less than 1%—with superior temperature control and unapproached economy of operation on high production schedules such as we have today.

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AJAX ELECTRIC COMPANY, INC., The Ajax-Hultgren Electric Salt Bath Furnace
AJAX ENGINEERING CORPORATION, Ajax-Tama-Wyatt Aluminum Melting Induction Furnaces

News Digest

atomic energy engineering, the technical manpower situation, and the encouragement of fundamental research as an aid to engineering education.

Leaders in technological education from all countries outside the Iron Curtain have been invited to attend.

The ASEE was founded in 1893 as the Society for the Promotion of Engineering Education. It has nearly 200 institutional members, including every accredited engineering college in the United States, and more than 7200 individual members from engineering and scientific institutions and from industry.

News of Engineers

I. J. Groce, formerly of the U. S. Bureau of Mines, has accepted a position as chemical engineer with Metal Hydrides Inc.

Thomas C. Jackson has been appointed chief Engineer of Michigan Limestone Div., United States Steel Corp. Mr. Jackson succeeds *Robert H. Lucas,* who will become assistant to the president of the company's Pittsburgh Steamship Div.

Chester Hall, pioneer inventor, has retired from General Electric Co. after 34 years of service. Mr. Hall's inventive career has been marked by major engineering contributions in the fields of refrigerator controls, synchronous time systems, aircraft and marine engines, dairy equipment and motor starters.

Westinghouse Electric Corp. has announced the following appointments: *C. H. Brechin* as manager of the Porcelain Dept.; *E. T. Morris* as assistant manager of the Atomic Power Div.; Dr. *Charles M. Slack* as director of research and engineering, Lamp Div.

Joseph E. Berman has been elected president and chairman of the board of Industrial Metal Protectives, Inc.

Clearing Machine Corp. recently appointed *Gordon M. Sommers* chief engineer of its Hamilton, Ohio plant.

Paul D. Cornelius has been named to head the Design and Research Dept. of Vlier Engineering, Inc.

Directors of National Lead Co. have made *F. J. Koegler* a vice president of the company and general manager of its newly-formed Doehler-Jarvis Div.

Marve Narramore has joined the Drop

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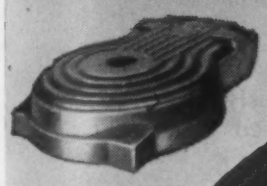

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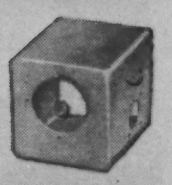
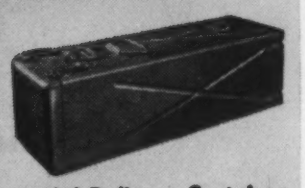
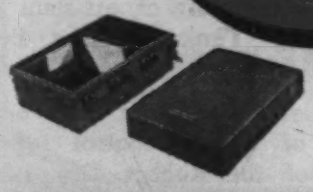


Solenoid Cover U.S. Navy



Aerial Delivery Container U.S. Air Force



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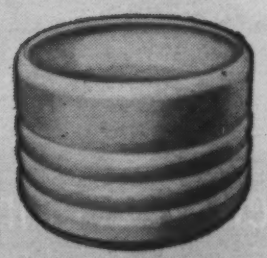
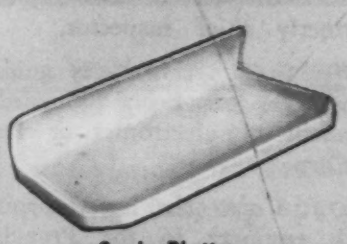
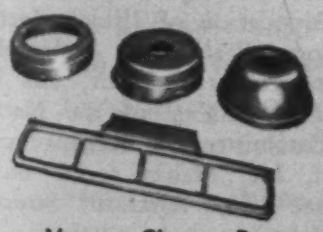


Washing Machine Tub



Scale Platter

Safety Guard for Power Tools



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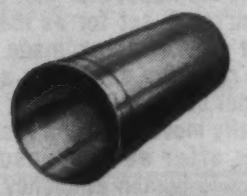
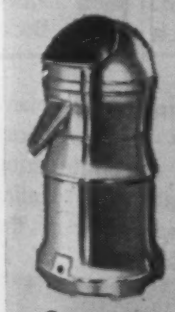
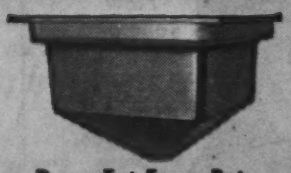


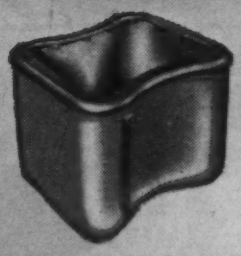
Longhorn Cheese Mold



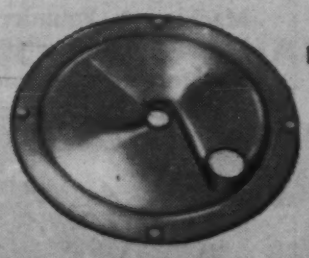
Commercial Fruit Juicer



Deep Fat Fryer Pot

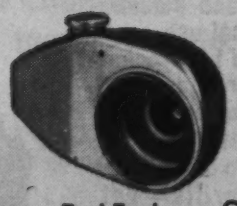


Transmitter Case



Cover for Ice Cream Freezing Equipment

Christmas Tree Stand



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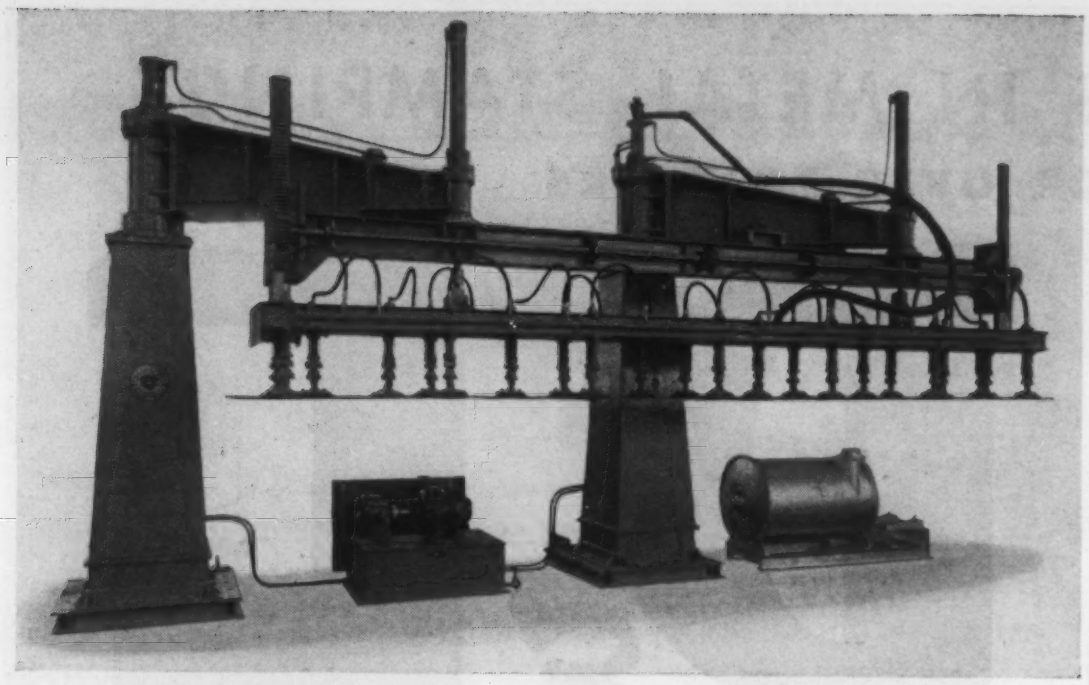

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Motorized For Sequence and Remote Control Photos

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Takes any standard film—color, too. Gets 50% more pictures, with 55 exposures instead of 36 per loading. Choice of Schneider lenses, wide angle to telephoto. For new camera thrills—get Robot-Star—from $217.50.

Write for authoritative treatise T—"New Techniques in Photography for Industry and Science"—Sent without charge.

Now equipped to take 35mm standard cartridges.

Gets the action every time because it's "Motorized!

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News Digest

Forging Association as staff engineer. Mr. Narramore previously served as managing director of the Feed Institute.

B. E. Bassett, vice president, Olin Industries, Inc., has been appointed general manager of the United States Defense Corp., an Olin subsidiary which is operating the Ammunition Div. of the St. Louis Ordnance plant.

Thermal Transfer Corp. has announced the appointment of *Joseph V. Schleisner* as chief engineer.

Curtis L. Bates has joined Ryan Aeronautical Co. as assistant director of engineering. Mr. Bates was formerly associated with Northrop Aircraft, Inc., where he contributed to the development of its most advanced planes. Most recently he was director of mechanical design at Northrop.

James S. Walker has been named manager of technical service of Hooker Electrochemical Co.

Richard K. McConkey has been appointed to the post of assistant general manager by Timken Roller Bearing's Industrial Div.

Promotion of *George A. Fort* from manager of quality control to general manager of the Rubber Div. has been announced by Parker Appliance Co. Succeeding Mr. Fort will be *Anthony Fedewitz,* formerly chief inspector.

Gene B. Spaulding, formerly guidance group engineer, has been promoted to superintendent of electronics at Temco Aircraft Corp.

Vincent J. Volpe has been appointed a research engineer in the Propulsion and Structural Research Dept. at Armour Research Foundation of Illinois Institute of Technology. *William E. Mahin,* director of research at Armour, has been reappointed a member of the National Advisory Committee for Aeronautics. A metallurgist, Mr. Mahin serves on the Subcommittee on Aircraft Structural Materials.

James D. Wilkinson has been named manager, Market Research Div., Beckman Instruments, Inc.

R. J. Keller has joined Cleveland Welding Co., subsidiary of American Machine & Foundry Co., as engineering assistant to the president. Mr. Keller was formerly technical supervisor of the Aircraft Wheel and Brake Div., B. F. Goodrich Co.

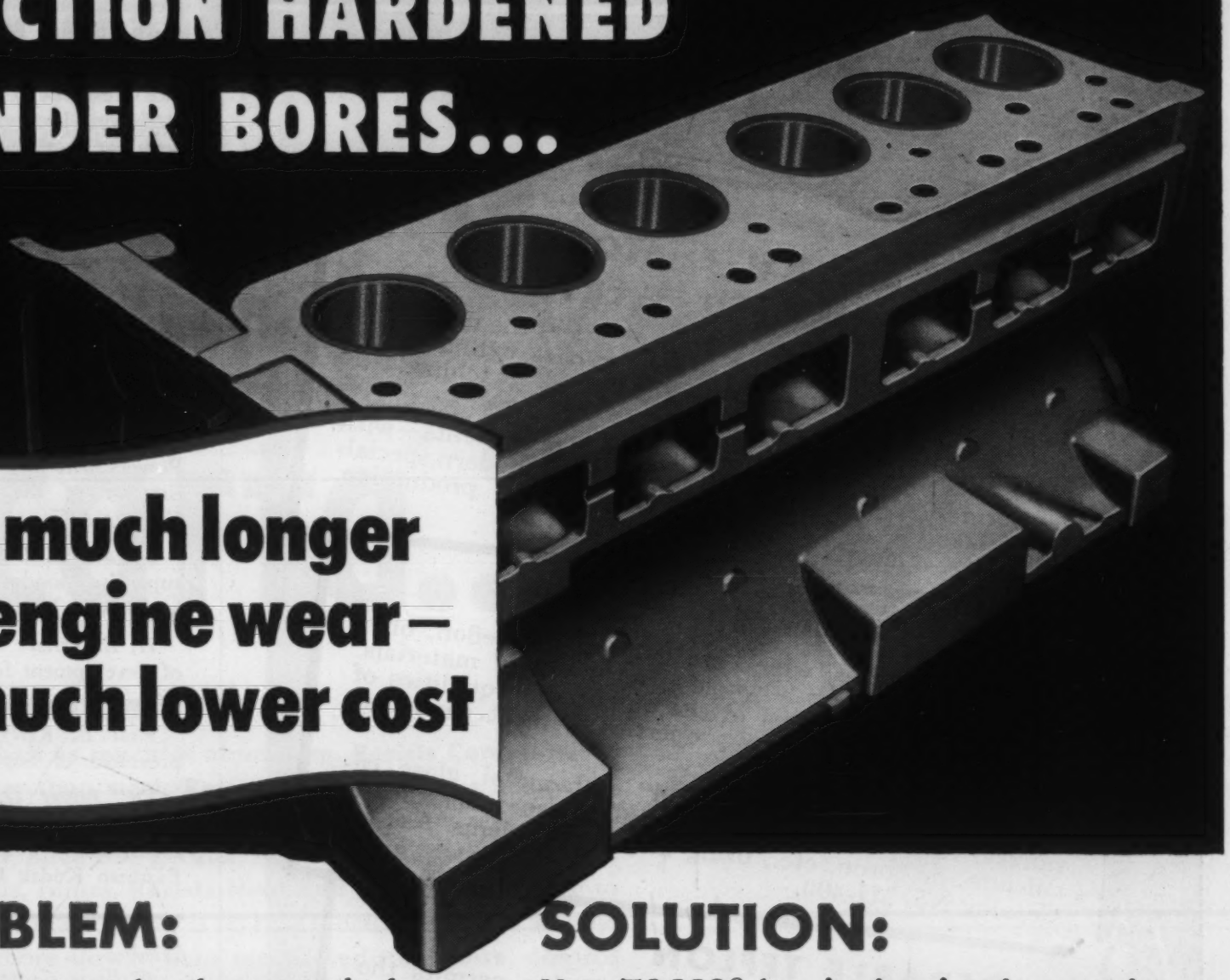
Victor Brown has been elected a vice president of Kropp Forge Co.

Benjamin C. Betner, Jr. has been elected a vice president of Continental Can Co. Mr. Betner was formerly president of the Benjamin C. Betner Co., whose assets and business were recently acquired by Continental Can Co.

Howard R. Silverthorn has been named

Another **TOCCO®** *First!*

INDUCTION HARDENED CYLINDER BORES...



for much longer engine wear— at much lower cost

PROBLEM:

Cylinder liners cost a lot of money, and, of course, they take up space that could be used for generating extra horsepower.

As a result engine builders, hoping to abolish the need for liners, experimented with various hard alloy irons that can furnish desired hardness in the cylinder bores.

However, these hard castings were extremely difficult to machine, and they cost several dollars per casting extra.

SOLUTION:

Now TOCCO® has developed and patented a process for Induction-hardening the cylinder bores of conventional, cylinder-iron castings. The blocks are easy to machine, yet cylinder bores are very hard to a depth of about 1/16". This depth of hardness permits several re-honings with no loss of hardness in the cylinder bore.

The cost?—less than half the extra cost of alloy iron cylinder blocks.

This important development is typical of the way TOCCO works hand-in-glove with the Metal Working Industry to improve products and lower costs.

see our catalog in MACHINE TOOL CATALOGS or write for copy

THE OHIO CRANKSHAFT COMPANY

TOCCO

Mail Coupon Today

NEW **FREE** BULLETIN

THE OHIO CRANKSHAFT CO.
Dept. T-4, Cleveland 1, Ohio

Please send copy of "Typical Results of TOCCO Induction Hardening and Heat Treating"

Name_____

Position_____

Company_____

Address_____

City_____ Zone___ State_____

For the "Firsts" in Fluorocarbons

SEE U.S.G.

TEFLON* and KEL-F† STOCK and FABRICATED PARTS

The United States Gasket Company offers the most complete line of sheets, rods, tape, tubing, bars, cylinders and fabricated parts — custom-molded and machined to specifications.

This means one source for all your requirements—with uniform high quality assured by the most modern specialized facilities for low-cost, close-tolerance production. Ask for Catalog No. 300 and 500.

TEFLON "ALLOYS"

Chemelec Mixtures, which are "alloys" of Teflon, offer the product engineer a whole new family of materials. These alloys retain most of the outstanding qualities of pure Teflon and add new properties to meet particular material requirements.

If you want TEFLON "alloyed" with metal, glass, ceramics, carbon, mica, quartz, alnico, asbestos, silicate, calcium, or boron, etc., bring us your problems. Ask for Catalog No. MI-400.

SOLDERABLE TEFLON

Chemelec Multi-Bond Metal Faced Teflon permits the bonding and hermetic solder sealing of this dielectric material to metal components.

The bond between metal surface and the Teflon is microcrystalline in nature—an interlocking metal-permeated surface layer of the fluorocarbon.

Metal facings include practically all the ferrous and nonferrous metals, the ferro-magnetic group and the precious metals. Catalog No. MI-424.

CEMENTABLE TEFLON

Chemelec Multi-Bond Cementable Teflon is a specially prepared fluorocarbon which will adhere to metal, glass, wood, fibre, asbestos, plastics, leather, ceramics, or other substances by the use of suitable commercial cement.

A broad field of electrical, mechanical and chemical applications is opened to product engineers. Write for Catalog No. MI-443.

UNITED STATES GASKET COMPANY

FLUOROCARBON PRODUCTS DIVISION
CAMDEN 1, NEW JERSEY

Representatives in Principal Cities Throughout the World

*du Pont Trademark
†M.W. Kellogg Trademark

News Digest

plant engineer and *N. R. Gorris* master mechanic at Chrysler Corp.'s Trenton, Mich., Engine Plant.

Theodore L. Pantz has been named vice president in charge of manufacturing at Servel, Inc., and *Jack A. Scarlett* has been appointed to the newly created position of manager of manufacturing engineering.

Charles W. Smith has been named works manager of the Borden Co.'s Chemical Div. plant at Bainbridge, N. Y.

Lawrence H. Lemke has been appointed general superintendent of D. J. Murray Mfg. Co.

E. D. Powers has been elected president of Chemical Construction Corp. Mr. Powers will remain as vice president and director of the parent firm, American Cyanamid Co.

Samuel A. Wenk has been named to supervise nondestructive testing research at Battelle Memorial Institute.

H. E. Spitzer has been named director of development for the Sherwin-Williams Co.

Paul E. Kelly has been named vice president of Superior Tube Co.

Dr. *James G. Baxter* has been appointed assistant director of research, Distillation Products Industries Div., Eastman Kodak Co.

Died . . .

William Grote, chairman of the board of Grote Manufacturing Co. and of the Grotelite Co.

Frank H. Gordon, retired vice president of Lukens Steel Co.

Melvin H. Kuhl, assistant general manager of the Industrial Div., Timken Roller Bearing Co.

Theodore B. Drescher, vice president of Bausch & Lomb Optical Co.

News of Companies

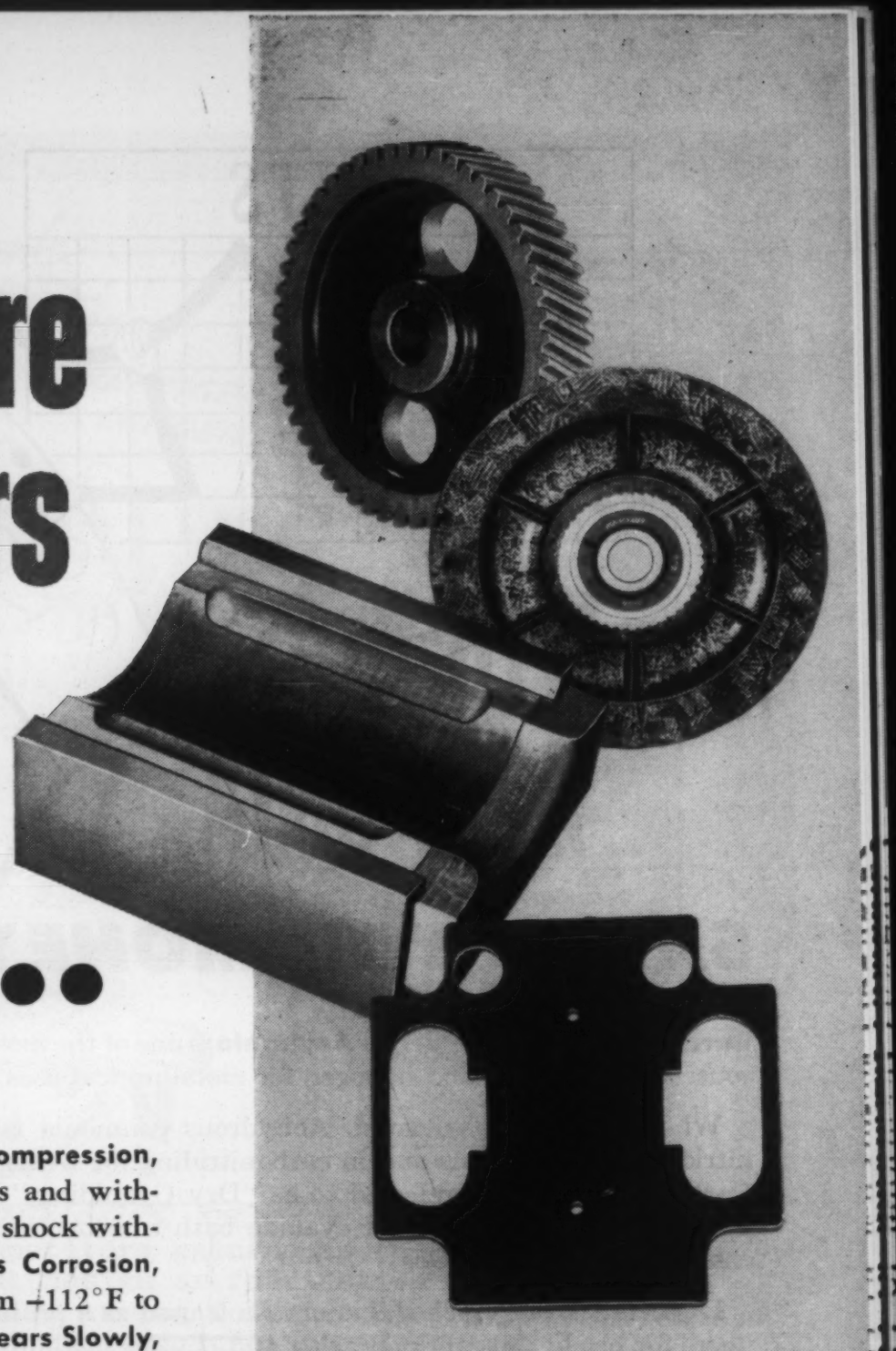
Pittsburgh Plate Glass Co. is offering a four-year science and engineering scholarship to an outstanding high school senior at Mt. Vernon, Ohio, site of the firm's largest window glass producing plant.

An entirely new research center for developing new and better steels and steel technology will be constructed by *U. S. Steel Corp.* The center will be located in a rural area of Allegheny County near Pittsburgh.

Oliver Iron and Steel Corp. has announced the location of a new general

Here's why...

more and more manufacturers are turning to micarta®...



Because of these qualities . . .

Saves Weight, weighs half as much as aluminum. **Resists Compression,** pound for pound greater than steel. **Resists Impact,** absorbs and withstands severe shock. **Withstands Vibration,** cushions repeated shock without effect. **Insulates** like mica but greater flexibility. **Resists Corrosion,** not affected by acids, oils, fumes. **Resists Heat and Cold** from −112°F to 212°F. **Resists Moisture,** in fact, water is its best lubricant. **Wears Slowly,** evenly, in many cases more slowly than metal. **Reduces Noise,** absorbs vibrations, deadens noise. **Fabricates Easily,** machined or punched with ordinary tools.

Because of these flexibilities . . .

Laminated MICARTA includes standard structural shapes: plates, sheets, angles, channels, rods, tubes and zees. Occasionally this class includes simple molded shapes. **Molded MICARTA** is the choice for complicated shapes, large production quantities of either simple or complicated shapes, or for certain properties better obtainable in form molding.

Because micarta is basic . . .

MICARTA is a tough and resilient basic material that welcomes comparison with other basic materials. This versatile plastic outlasts wood and metal in many punishing applications. Investigate MICARTA and you'll find it the economical solution to tough production problems.

for more information on how MICARTA can help solve your production problems, and give you advantages no metal can give you, please fill out the coupon below. A MICARTA representative will then call on you personally.

mail it today!

YOU CAN BE SURE...IF IT'S

Westinghouse

micarta

Westinghouse Electric Corporation
MICARTA Division, Trafford, Pa.
Attention: L. A. Pedley

Sir: (Please Check One)

☐ Please have your representative call

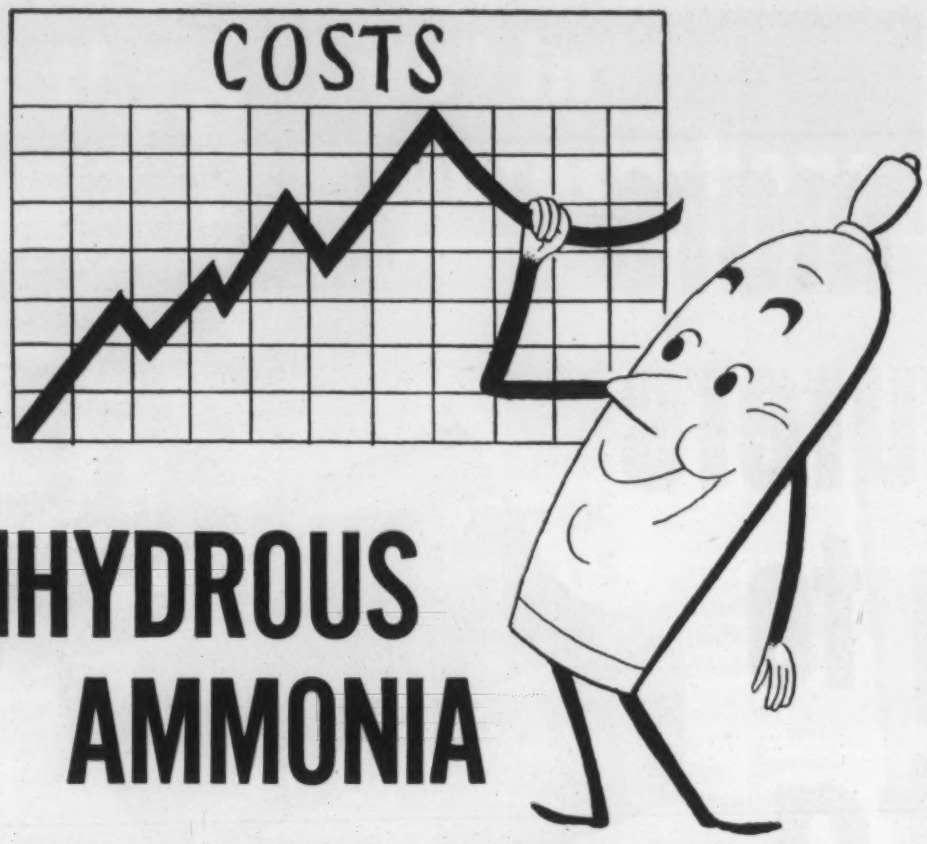
☐ Please send me the complete facts on MICARTA

Name_____ Company_____

Address_____

City_____ Zone_____ State_____

J-06500-B



ANHYDROUS AMMONIA

SAVES YOU MONEY!

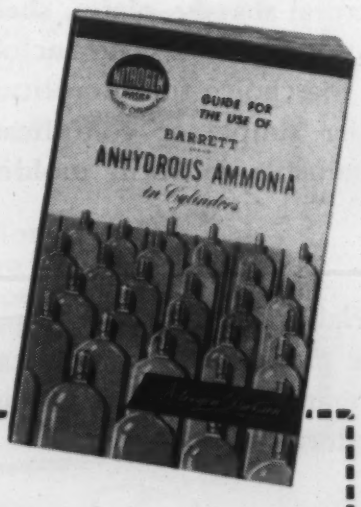
Barrett® Brand Anhydrous Ammonia is one of the most economical sources of hydrogen and nitrogen for metallurgical uses.

When partially dissociated, Anhydrous Ammonia is used in the nitriding of alloy steels and in carbonitriding for treatment of steel. Carbonitriding, often referred to as "Dry Cyaniding," has in many instances replaced the liquid cyanide bath to economically produce cases on low carbon steels.

Dissociated, or "cracked," ammonia is used as a protective atmosphere for bright annealing, brazing and powder metallurgy. It is also used as hydrogen for welding, for descaling metals by the sodium hydride process, and as an economical source of hydrogen in electronics. In addition, it is used in the hydrogenation of fats and oils.

NITROGEN DIVISION ALLIED CHEMICAL

Write for full information on how Barrett® Brand Anhydrous Ammonia can save you money. The advice and help of our technical men are available to you without charge.



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Mail Coupon for your free copy of this new booklet. Helpful, informative, contains latest data on the use of Anhydrous Ammonia.

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mm

News Digest

sales office, Oliver Bldg., Pittsburgh 22, Pa.

Inland Steel Container Co., a wholly-owned subsidiary of *Inland Steel Co.*, has become a division of the parent company.

National Lead Co. will operate its newly-acquired *Pioneer Alloy Products Div.* as a part of its metal department.

A new plant for expanded production of Bakelite fluorothene resins is now under construction at S. Charleston, W. Va., by *Bakelite Co.* The company expects this continuous process plant to be completed by the middle of 1953.

Fiber Glass Div., Pittsburgh Plate Glass Co. has already begun production in its new Shelbyville, Ind., facility. The plant is being equipped to produce both the superfine fiber glass and the fiber glass yarn.

International Glass Corp. has purchased all the plant facilities and equipment of the *Perrault Glass Fiber Corp.* in Newport, Ark.

The recently completed *Air Reduction Sales Co.* liquid oxygen plant in Butler, Pa., has commenced delivery of oxygen to industrial customers. The plant, which represents an outlay of several million dollars, supplies oxygen directly by pipeline to two Butler customers, *Armco Steel Corp.* and *Pullman Standard Co.*

Ground was broken recently for the new two million dollar *Beckman Instruments'* factory and administrative offices to be erected on the 40-acre site between Ocean Ave. and Imperial Blvd. on Highway 101 in the La Habra-Fullerton area of S. Pasadena, Calif.

Building what amounts to a new plant in and around its existing structures, *Standard Pressed Steel Co.* is rapidly pushing to conclusion a $10,000,000 machinery and new-plant expansion program. When the program is finished in mid 1953, the company will have more than 650,000 sq. ft. of integrated floor space under one roof.

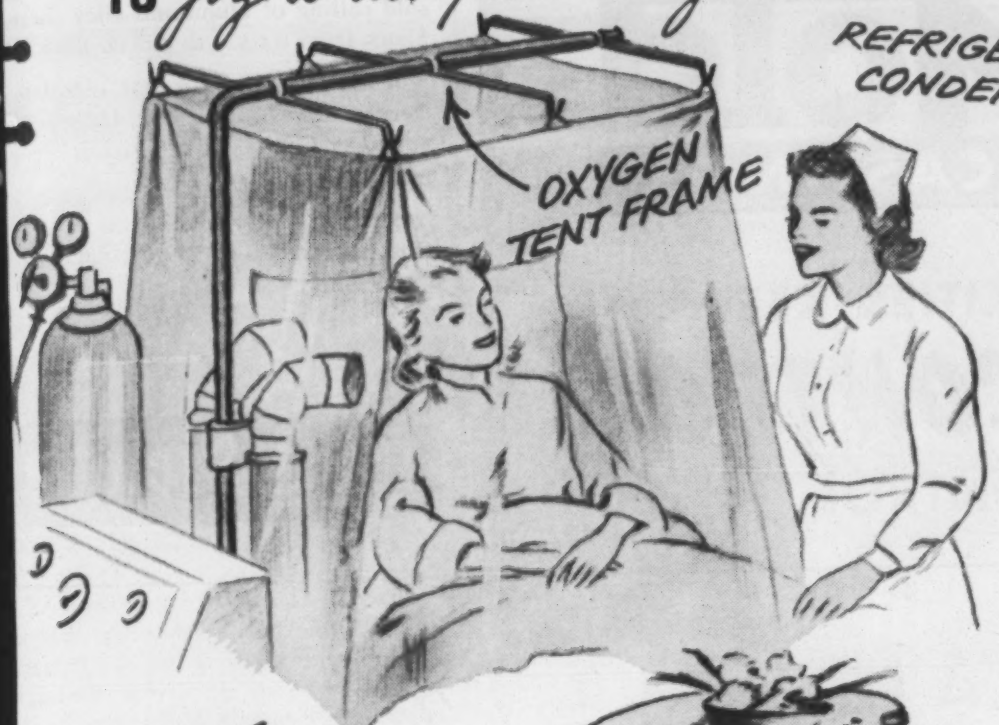
Metalwash Machinery Corp. recently expanded and modernized the main office building of its Elizabeth, N. J., plant.

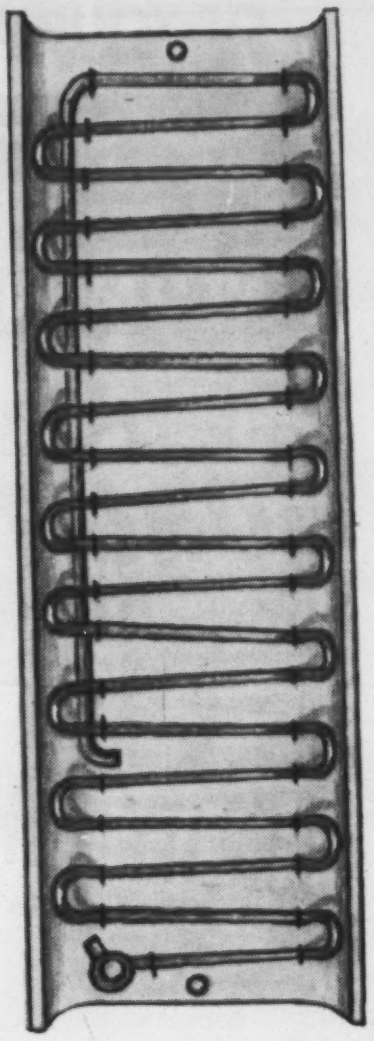
Scully-Jones & Co. has recently completed an extensive expansion program in its present Chicago location. The program includes a new building that adds 14,000 sq ft to supply much needed space.

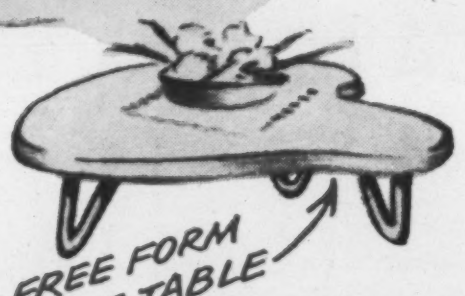
General Chemical Div., Allied Chemical & Dye Corp., plans to build a large research laboratory at Morristown, N. J. The new facility will replace the division's present laboratory at Laurel Hill, L. I., N. Y.

Hydropress, Inc. is designing and building a new type rolling mill for the fabrication of tapered aluminum alloy plates and sheets. The mill is expected to be the largest installation of its kind

FROM *the Bundy Sketchbook*
TO *jog a designer's imagination*







REMARKS What's your tubing problem? Are competitors gaining an edge while you iron out design or fabrication kinks? Are unexpected tubing failures eating into profits? Skilled Bundy engineers can help solve that design or fabrication problem; save time, materials, money. And dependable Bundyweld Tubing will help eliminate those annoying, sometimes costly, failures.

WRITE → today for catalog or for help on your tubing idea or problem.
BUNDY TUBING CO., DETROIT 14, MICH.

Bundyweld Tubing

® DOUBLE-WALLED FROM A SINGLE STRIP

Leakproof
High thermal conductivity
High bursting point
High endurance limit
Extra-strong
Shock-resistant
Ductile

Lightweight
Machines easily
Takes plastic coating
Scale-free
Bright and clean
No inside bead
Uniform I.D., O.D.

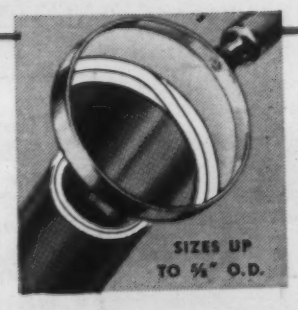
WHY BUNDYWELD IS BETTER TUBING

Bundyweld starts as a single strip of copper-coated steel. Then it's . . .

continuously rolled twice around laterally into a tube of uniform thickness, and

passed through a furnace. Copper coating fuses with steel. Result . . .

Bundyweld, double-walled and brazed through 360° of wall contact.



← **NOTE** the exclusive patented Bundyweld beveled edges, which afford a smoother joint, absence of bead and less chance for any leakage.

Bundy Tubing Distributors and Representatives: ***Cambridge 42, Mass.:*** Austin-Hastings Co., Inc., 226 Binney St. • ***Chattanooga 2, Tenn.:*** Peirson-Deakins Co., 823-824 Chattanooga Bank Bldg. • ***Chicago 32, Ill.:*** Lapham-Hickey Co., 3333 W. 47th Place • ***Elizabeth, New Jersey:*** A. B. Murray Co., Inc., Post Office Box 476 • ***Philadelphia 3, Penn.:*** Rutan & Co., 1717 Sansom St. • ***San Francisco 10, Calif.:*** Pacific Metals Co., Ltd., 3100 19th St. • ***Seattle 4, Wash.:*** Eagle Metals Co., 4755 First Ave. South ***Toronto 5, Ontario, Canada:*** Alloy Metal Sales, Ltd., 181 Fleet St., E. • **Bundyweld nickel and Monel tubing is sold by distributors of nickel and nickel alloys in principal cities.**

PROGRESS AT THE FOUNDRY LEVEL OF YOUR PRODUCTION WITH

perMold
ALUMINUM CASTINGS

perMold FACILITIES KEEP

QUALITY CONTROL

UNDER CONTROL

Write Today . . . for valuable, informative literature illustrated above; "Quality Control Under Control", a 6-page brochure graphically describing how Permold facilities save time, improve product, reduce ultimate cost in the manufacture of aluminum castings; Permold Technical Reference Booklet PMC 45, containing practical suggestions on design of parts for aluminum permanent mold casting and data on alloy composition.

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820 West Liberty Street
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Please send ☐ new Brochure, "Quality Control Under Control" ☐ Permold Technical Reference Booklet PMC 45.

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Position _____

Company _____

Address _____

News Digest

in the world. It will permit the hot or cold rolling of aluminum alloy sheets and plates from 0.032- to 3.0-in. thick.

Wickman Mfg. Co. has completed the construction of its new factory located at 10325 Capital Ave., Detroit.

A new Syracuse, N. Y., office has been opened by *American Lava Corp.* The office is located at 330 Arlington Ave.

News of Societies

Armour Research Foundation of *Illinois Institute of Technology* has signed a three-year contract to reorganize and expand the State Industrial Research Institute of Burma in Rangoon. Dr. Christopher E. Barthel, Jr., assistant director at the Foundation, will serve as resident director of the Burmese Institute.

R. A. O'Brien, assistant to the chairman of the mechanisms and dynamics dept. at Armour Research Foundation of Illinois Institute of Technology, has been appointed to a national committee of the *American Society of Mechanical Engineers*. Mr. O'Brien is secretary of a research committee that will study the plasticity of metals, especially in the rolling and forging of steel.

The Cast Iron Soil Pipe Institute has elected J. W. Struve, president of Rich Mfg. Co., as its president for 1953. Also elected were Frank Hamilton as vice president, and Deems W. Hallman as treasurer.

The Standards Engineers Society has elected the following officers for 1953: William L. Healy, General Electric Co., president; Madhu S. Gokhale, Radio Corp. of America, vice president; Fred M. Oberlander, Radio Corp. of America, Secretary; and Harold J. Nugent, manufacturers' representative, treasurer.

Boston College is offering a special two-weeks intensive course in Modern Industrial Spectrography at Chestnut Hill, Boston, from July 20 to July 31. The course is particularly designed for chemists and physicists from industries in the process of installing spectrographic equipment. Further information can be obtained from Prof. James J. Devlin, S. J., Physics Dept., Boston College, Chestnut Hill 67, Boston.

Program details have been announced for the 14th semi-annual *X-Ray Diffraction School* to be held at the application laboratory of North American Philips Co., Inc., 750 S. Fulton Ave., Mt. Vernon, N. Y. during the week of Apr. 20-24. Details can be obtained by writing to the company.

Here's where LUMNITE Concrete*

SAVED TWO WEEKS' WORK

Built to take the soaking heat of a continuous heat-treating furnace, this Heat-Resistant Concrete foundation was placed in 9 hours. Lumnite cement was used with pre-soaked Lelite aggregates.

POURED MONDAY... READY TUESDAY—That's the short, profitable story of this Heat-Resistant Concrete flue and foundation for a Wire Patent Furnace at John A. Roebling's Sons, Roebling, N. J. Their superintendent reports substantial savings on the job. And small wonder. It is estimated that by conventional methods this job would have taken about 2 weeks more to complete!

SIMPLE MONOLITHIC CONSTRUCTION is *naturally* faster than laying up thousands of small units. And Lumnite Concrete reaches service strength in 24 hours or less. That cuts outage time on both Heat-Resistant and Refractory jobs. Moreover, upkeep costs are low because Lumnite Concrete withstands severe thermal shock, resists corrosion and abrasion, and, with suitable aggregates, takes heat to 2600°F.

WHETHER YOU NEED Heat-Resistant, Refractory or Insulating Concrete, you can make it quickly, easily and economically with Lumnite calcium-aluminate cement and the proper aggregates. It has a proved time- and cost-saving record for flues and furnace foundations, and for door linings, car tops, base pads, foundry floors, stack linings and many other installations.

FOR CONVENIENCE you may prefer to buy prepared Castable mixes. These packaged mixtures of Lumnite and selected aggregates are tailor-made to meet your specific temperature and *insulation* requirements. Add only water. They're made by refractory manufacturers and sold through their dealers. For more information write: Lumnite Division, Universal Atlas Cement Company (United States Steel Corporation Subsidiary), 100 Park Ave., New York 17, N. Y.

**"LUMNITE" is the registered trade mark of the calcium-aluminate cement manufactured by Universal Atlas Cement Company.*

MM-L-60-R

ATLAS® **LUMNITE for INDUSTRIAL CONCRETES**

REFRACTORY, INSULATING, OVERNIGHT, CORROSION-RESISTANT

"THE THEATRE GUILD ON THE AIR"—*Sponsored by U. S. Steel Subsidiaries—Sunday Evenings—NBC Network*

"SERV-RITE"

Insulated Thermocouple Wire Extension Lead Wire

FOR

PLATINUM COUPLES
CHROMEL ALUMEL
IRON CONSTANTAN
COPPER CONSTANTAN
IRON CUPRONEL

No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

All Types of Insulation

Felted Asbestos
Asbestos Braid
Weatherproof Braid
Glass Braid
Polyvinyl Plastic
Nylon Braid
Stainless Steel Armored Braid
Silicone Treated
Cotton Braid
Lead Jacket

The home of "SERV-RITE"

Full Particulars on Request

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Meetings and Expositions

METAL POWDER ASSOCIATION, annual meeting. Cleveland. Apr. 20-22, 1953.

SOCIETY OF AUTOMOTIVE ENGINEERS, spring aeronautical meeting. New York. Apr. 20-23, 1953.

AMERICAN ZINC INSTITUTE, annual meeting. St. Louis. Apr. 27-28, 1953.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, spring meeting. Columbus. Apr. 28-30, 1953.

OAK RIDGE INSTITUTE OF NUCLEAR STUDIES, symposium. Oak Ridge, Tenn. Apr. 30-May 1, 1953.

AMERICAN FOUNDRYMEN'S SOCIETY, annual convention. Chicago. May 4-8, 1953.

SOCIETY OF THE PLASTICS INDUSTRY, annual meeting. On board the Queen of Bermuda—New York to Bermuda and back. May 9-15, 1953.

AMERICAN INSTITUTE OF MINING & METALLURGICAL ENGINEERS, Pacific Northwest metals and mineral conference, joint meeting, Metals Branch and Industrial Minerals Div. Seattle. May 14-16, 1953.

OPERATIONS RESEARCH SOCIETY OF AMERICA, annual meeting. Cleveland. May 15-16, 1953.

SOCIETY FOR EXPERIMENTAL STRESS ANALYSIS, spring meeting. Milwaukee. May 20-22, 1953.

COPPER & BRASS RESEARCH ASSOCIATION, annual meeting. Hot Springs, Va. May 24-27, 1953.

SCIENTIFIC APPARATUS MAKERS' ASSOCIATION, annual meeting. Chicago. May 24-28, 1953.

AMERICAN IRON & STEEL INSTITUTE, general meeting. New York. May 27-28, 1953.

SOCIETY OF AUTOMOTIVE ENGINEERS, summer meeting. Atlantic City. June 7-12, 1953.

MALLEABLE FOUNDERS' SOCIETY, annual meeting. Hot Springs, Va. June 8-10, 1953.

AMERICAN ELECTROPLATERS' SOCIETY, annual meeting. Philadelphia. June 15-18, 1953.

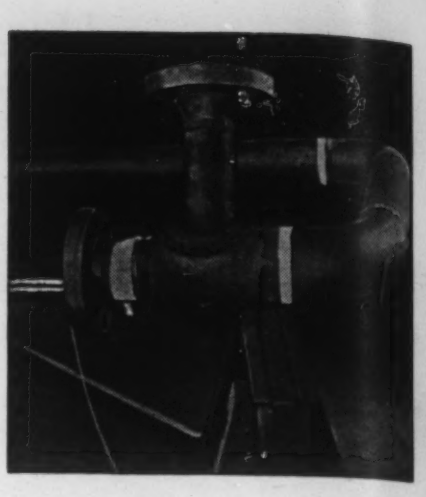
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, summer general meeting. Atlantic City. June 15-19, 1953.

FIRST EXPOSITION OF BASIC MATERIALS FOR INDUSTRY, New York. June 15-19, 1953.

AMERICAN WELDING SOCIETY, national spring technical meeting. Houston. June 16-19, 1953.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS, semi-annual meeting. Los Angeles. June 28-July 2, 1953.

AMERICAN SOCIETY FOR TESTING MATERIALS, annual meeting. Atlantic City. June 29-July 3, 1953.



Use

THIS PHOTO shows radium being used to take a radium-radiograph of a weld. Placing the radium centrally in the pipe and the film on the outside (held in place by white tape) permits radiographing the entire circumferential weld with one exposure.

RADIUM

for the tough weld inspection jobs

because radium-radiographing equipment is

1. Portable
2. Easily handled
3. No training needed to operate
4. Economical

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For the same reasons that radium-radiography has won nearly universal acceptance in steel foundries throughout the country, it is becoming the preferred means of inspection in welding shops.

No capital investment is required to have radium-radiography available for the inspection of welds because the equipment may be rented or leased with economy.

Write today for case histories and additional information.

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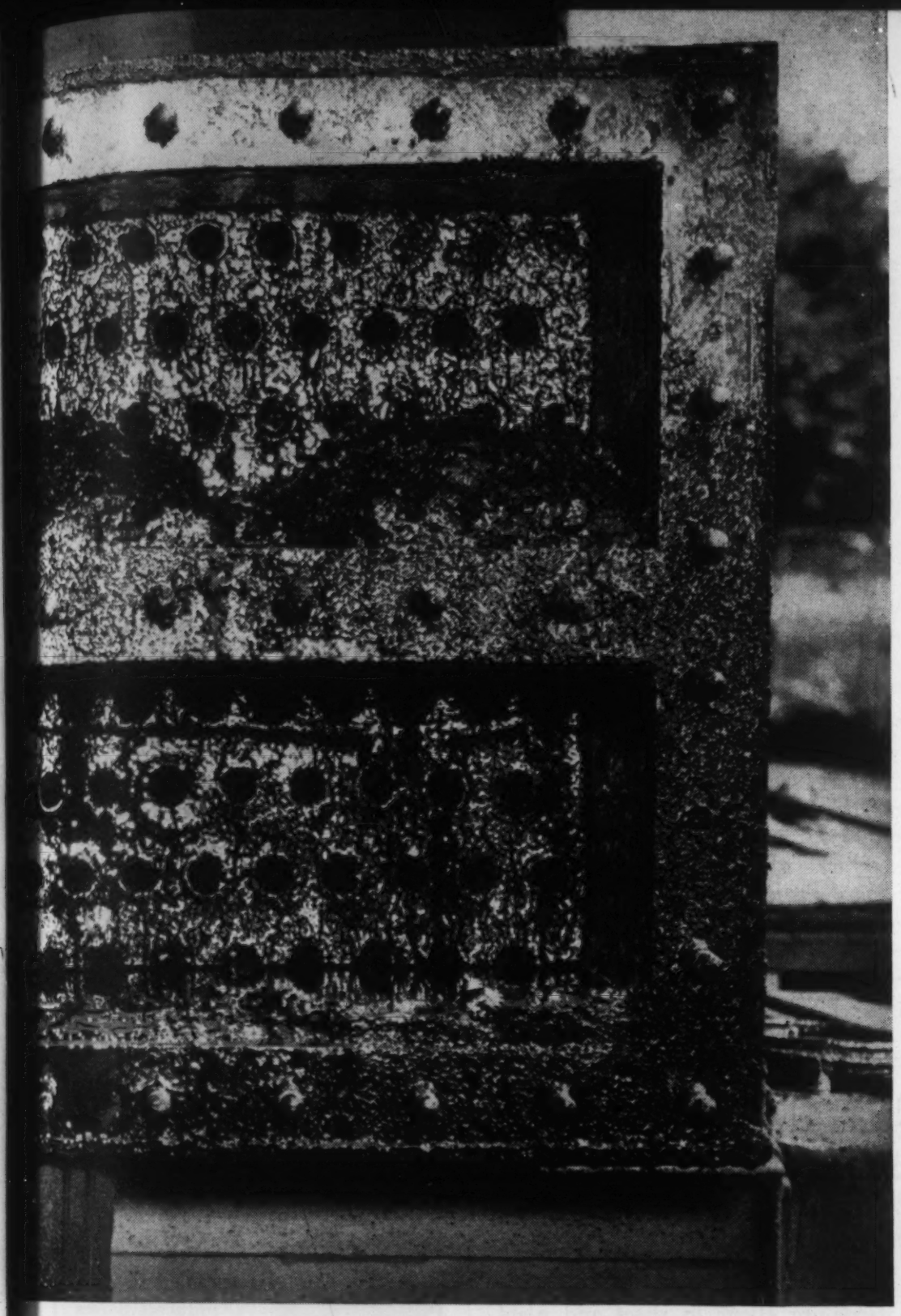


Sun Quenching Oil

Sun Quenching Oils Reduce Operating Costs
Sun oils thin out when heated, drain off parts faster and more completely. Dragout is reduced to a minimum. They do not thicken up, and under normal operating conditions need never be replaced. For more information about Sun Quenching Oils, call your nearest Sun office or write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. ML-4.

INDUSTRIAL PRODUCTS DEPARTMENT
SUN OIL COMPANY
SUNOCO®

PHILADELPHIA 3, PA. ◆ SUN OIL COMPANY LTD., TORONTO & MONTREAL

Technical Reports on Materials

BEARING STRENGTHS OF SOME 75S-T6 AND 14S-T6 ALUMINUM-ALLOY HAND FORGINGS. *E. M. Finley, Aluminum Co. of America (1953). NACA TN 2883, 24 pp. Available from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.* Bearing properties of hand forgings were ascertained in the longitudinal and long transverse directions and in surface and center locations; they showed less directional or locational variations than did tensile properties. Ratios of bearing to longitudinal tensile strengths are summarized and nominal values are recommended for use in selecting design bearing strengths.

EXPLORATORY INVESTIGATIONS OF THE RESISTANCE OF SOME METALS UNDER STRESS. *L. G. Hoxton, Univ. of Virginia (1952). Report N-19616, 51 pp. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.* Conducting properties of metals under longitudinal stresses, particularly within their elastic ranges.

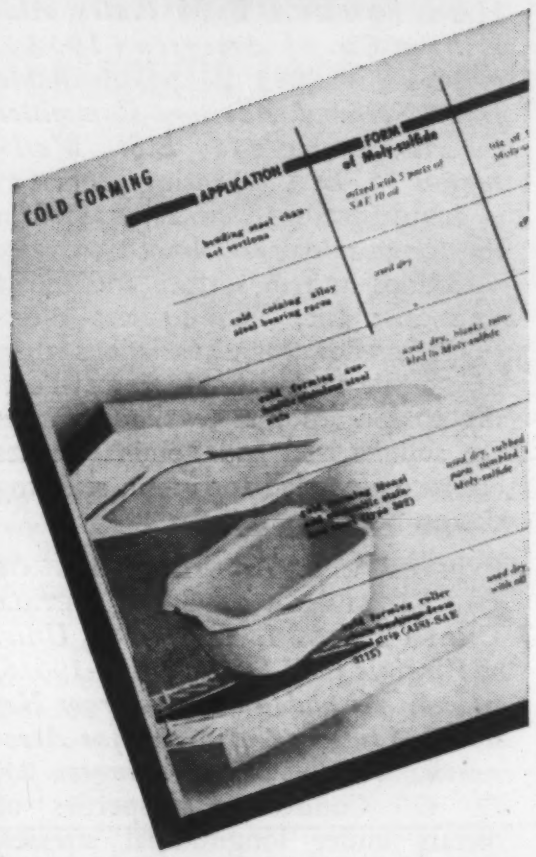
SELECTED GOVERNMENT RESEARCH REPORTS. VOL. 10: CERAMICS AND GLASS. *Great Britain Ministry of Supply (1952). Report PB 107912, 166 pp. Available from British Information Services, 30 Rockefeller Plaza, New York 20, N. Y. $5.75.* Use of ceramic coatings in gas turbine combustion chambers. Mechanical properties of sintered alumina. Thermal stresses in nonductile high temperature materials. Improvement of ceramics for use in heat engines. Experiments on hot pressing of zirconium carbide powder at 3650 F. Effect of surrounding atmosphere on delayed fracture of glass.

IMPROVED MAGNETIC MATERIALS. *First Quarterly Report for the Period Oct. 15, 1950 to Jan. 15, 1951. Lehigh Univ. Report PB 107813, 57 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $2.75, photostat $7.50.* Reduction of the mixed powders for 50 iron-50% cobalt cores prior to pressing may decrease coercive force, and prolonged sintering may improve saturation and retentivity.

(*Continued on page 228*)

Moly-sulfide
A LITTLE DOES A LOT

shows up best where the frictional conditions are difficult



The case-histories of 154 difficult friction problems in the shop and in the field, all successfully solved, are described in a new 40 page booklet.

It is where conditions are extreme that *Moly-sulfide* excels over other lubricants. If you encounter extreme conditions of pressure, temperature or velocity, send for this free booklet.

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Technical Reports . . . .

continued from page 227

IMPROVED MAGNETIC MATERIALS. *Second Quarterly Report for the Period Jan. 15, 1951 to Apr. 15, 1951. Lehigh Univ. Report PB 107814, 45 pp. Available from Library of Congress, Publication Board Project, Washington 25, D. C. Microfilm $2.50, photostat $6.25.* Magnetic properties of 50 iron-50% cobalt base alloys containing 0 to 0.6% titanium in sintered condition. Optimum properties produced using new apparatus to reduce oxygen content of iron and cobalt powders prior to pressing.

SKETCH OF DEGUSSA ORGANIZATION AND FORMULAE RELATING TO ENAMELS. *Deutsche Gold und Silberscheideanstalt (1946). Report PB 60903s2, 25 frames. Available from Library of Congress, Publication Board Project, Washington 25 D. C. Microfilm $2.00, enlargement prints $5.00.* Enamels for sheet and cast iron. Enamel formulas for copper and precious metals. Formulas for gas opacifiers, enamel colors, underglaze ceramic colors, and overglaze and glass colors.

AIRCRAFT PRIMARY STRUCTURES IN WELDED MAGNESIUM ALLOY. *Bristol Aeroplane Co., Ltd. (1951). Report N-20500, 28 pp. Available on loan from National Advisory Committee for Aeronautics, 1724 F St., Washington 25, D. C.* Use of magnesium-zirconium alloys in sheet and plate form, joined by arc welding, for primary structure of aircraft. Detailed description of welding equipment and technique used in the magnesium-zinc-zirconium sample found to be more promising from the standpoint of weldability, strength and resistance to stress corrosion.

THE APPLICATION OF SHELL MOLDING TO THE PRODUCTION OF MAGNESIUM CASTINGS. *U. S. Army Ordnance Corp. Report PB 111049. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.75.* Recommendations on inhibitors and mold materials to be used for successful shell molding of magnesium.

CURRENT STATUS OF THE SHELL MOLD OR "C" PROCESS OF PRECISION CASTING OF METALS. *O.T.S. Report PB 106640r (OTS IR 7734 revised) 20 pp. Available from Office of Technical Services, U. S. Dept. of Commerce, Washington 25, D. C. Mimeo $.25.*

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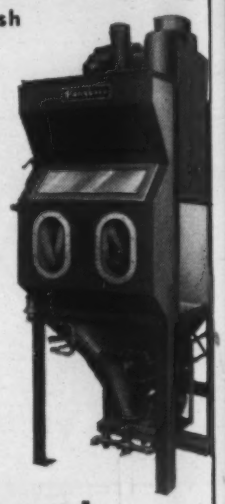

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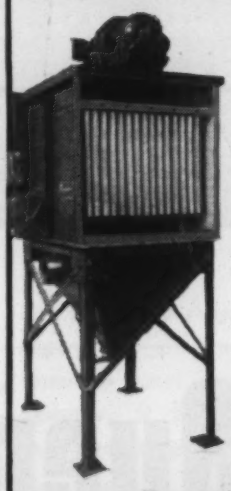

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Acetamide		●	●										●			●					
Acid Fluoboric	●	●		●			●	●	●	●	●	●	●			●					
Acid Hydrofluoric, Reagent		●		●			●			●	●										
Alkali Fluoborates							●	●		●	●										
Aluminum Chloride, Solution		●	●			●	●		●	●	●	●	●	●	●		●	●	●	●	●
Aluminum Fluoride, Crystal		●								●		●		●							
Aluminum Nitrate		●		●								●								●	
Ammonium Acetate						●				●		●		●				●		●	
Ammonium Oxalate			●		●				●	●			●	●			●	●		●	
Ammonium Sulfate Purified and Reagent A.C.S.	●	●				●	●		●	●				●		●	●			●	
Ammonium Thiosulfate				●					●	●				●	●					●	
Boron Trifluoride Gas and Various Complexes		●								●	●	●	●	●		●		●		●	
Cadmium Nitrate	●	●		●			●					●	●			●					
Calcium Acetate Purified and Reagent		●				●							●	●		●		●	●		
Calcium Chloride, Anhydrous Purified and Reagent A.C.S.				●		●										●					
Calcium Phosphide					●						●										
Chlorine Trifluoride		●														●					
Chromium Fluoride		●	●							●			●							●	
Chromium Nitrate		●														●					
Chromium Potassium Sulfate (Chrome Alum)		●	●						●				●	●			●			●	
Cupric Nitrate		●	●		●			●		●				●						●	
Cuprous Chloride	●	●	●		●						●	●	●	●		●				●	
Ferric Nitrate			●						●											●	
Ferrous Ammonium Sulfate		●	●							●								●			
Lead Nitrate		●	●		●				●		●	●	●	●	●		●		●	●	
Metal Fluoborates										●						●					
Oxamide					●																
Potassium Acetate		●		●					●	●				●		●	●			●	
Potassium Bifluoride		●		●			●			●										●	
Potassium Borate, Tetra										●											
Potassium Fluoride		●								●											
Potassium Nitrite		●	●			●				●		●						●	●		
Potassium Permanganate																					●
Potassium Titanium Fluoride											●							●			
Sodium Bisulfite, Meta Purified and Reagent						●								●						●	
Sodium Fluoride, Reagent A.C.S.								●					●								
Stannous Chloride		●	●					●	●	●			●						●	●	
Sulfur Hexafluoride				●																	

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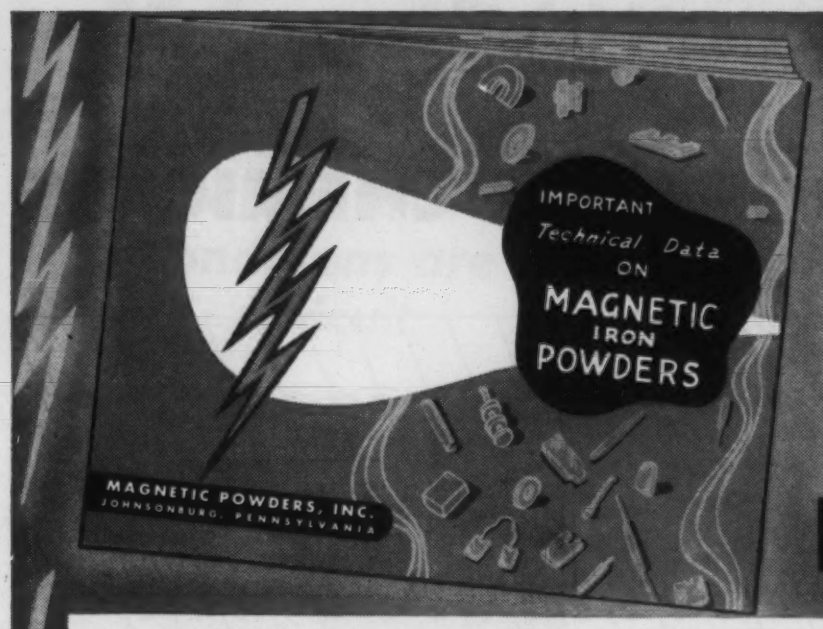

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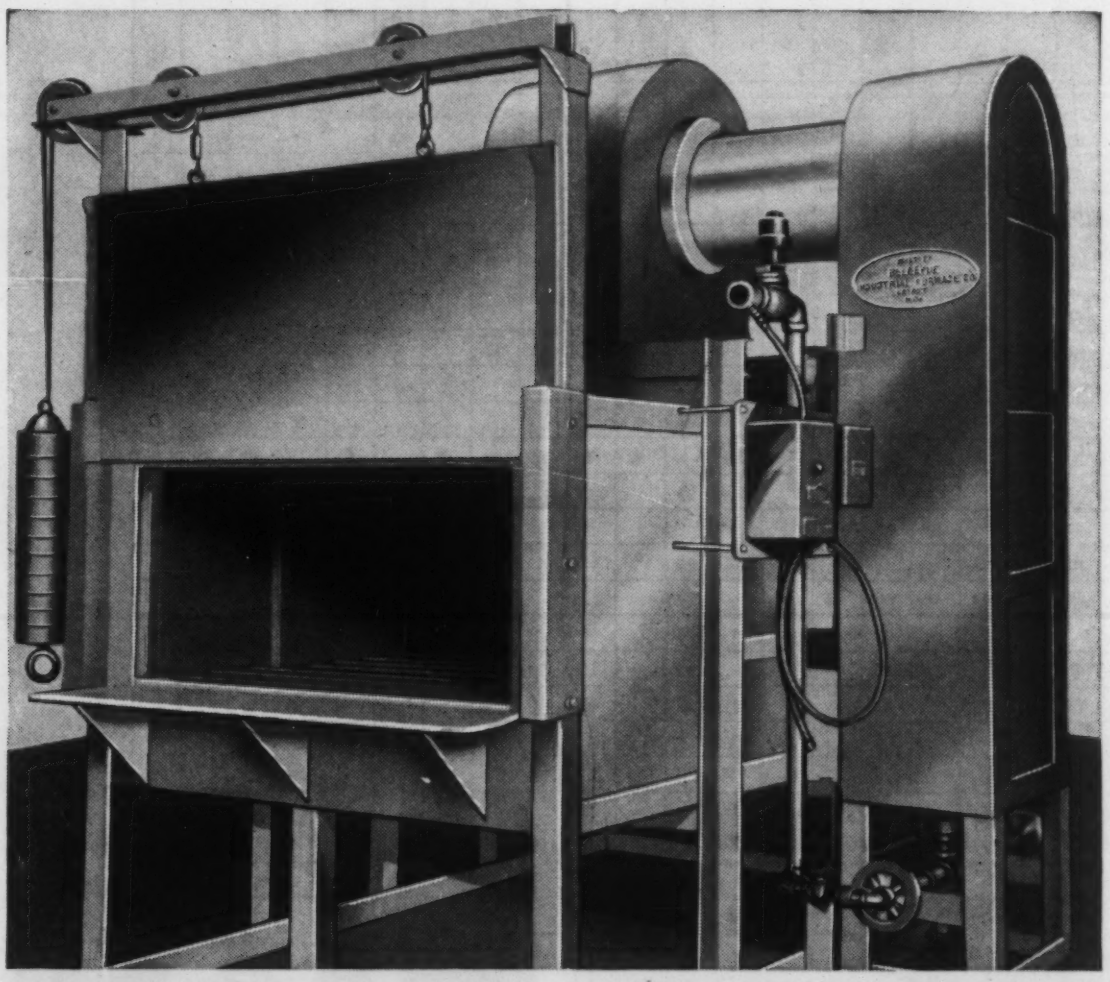

Batch type furnace for the heat treating of aluminum alloys—consists of atmosphere type burner mounted on the lower end of the combination chamber to reheat the re-circulated hot air through the furnace. A High Heat insulated recirculating fan is standard equipment for re-circulating the heated air. This method of heating holds temperature with little or no variation. Mounting the burner in the duct, eliminates the necessity of an extra heating unit. . . . Send us your heat treating problems . . . our engineers will make a proposal without obligation.

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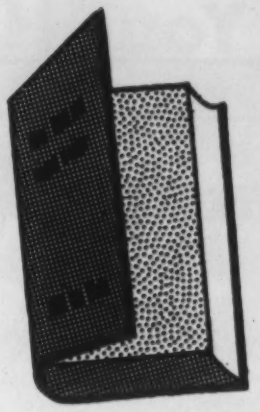

BOOK REVIEWS

Brazing

INDUSTRIAL BRAZING. *By H. R. Brooker and E. V. Beatson. Published by Iliffe & Sons Ltd., London, England, 1953. (Available through the British Book Centre, Inc., New York 22, N. Y.). Cloth, 6 by 9 in., 344 pp. Price $7.50.*

This authoritative study of brazing as a process for metal fabrication is expected to prove of equal value to those engaged in industries operating brazing processes as well as to those who are responsible for the design of brazed assemblies. Covered here in considerable detail are all modern brazing methods: torch, furnace, H.F. induction, resistance, salt bath and dip; while the special considerations necessary in work on aluminum, stainless steels, beryllium copper, cemented carbides and vacuum tube construction are dealt with separately. In addition, a general introduction to the processes and the equipment employed is followed by a review of brazing materials and a complete summation of the known factors governing joint design. Finally, a chapter discusses problems of selecting the most appropriate brazing process for various types of work and makes a useful contribution on methods of inspection and testing. Illustrated with over 200 photographs and diagrams describing in greater detail the various phases of the different processes, the work also contains helpful reference material both in the text and in the 32 tables.

Other New Books

THE COMPOSITION AND ASSAYING OF MINERALS. *By John Stewart-Remington and Dr. Wilfrid Francis. The Philosophical Library, Inc., New York 16, N. Y., 1953. Cloth, 5½ by 9 in., 128 pp. Price $5.50.* This book relates primarily to the chemical composition of minerals, with the object of providing a handy guide to their qualitative and quantitative examination which is suitable for use by mineralogists, metallurgists, geologists, etc.